THREE ESSAYS ON TAXATION AND CORPORATE FINANCE: EVIDENCE FROM JAPAN

BY

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DISSERTATION

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ABSTRACT

We address three topics on the relationship between taxation and corporate decision-making. A feature of our study is that we use natural experiments in Japan for identification as well as unique data sets of Japanese corporations. This research framework allows us to provide new evidence for several research questions that are difficult to be studied under the tax systems or with data sets in other countries such as in the U.S.

The first chapter examine the relationship between corporate tax asymmetries and high-risk investments. Economic theory dating to Domar and Musgrave (1944) suggests that the tax treatment of gains and losses can affect firms' incentives to undertake high-risk investments. We take advantages of a 2002 tax reform in Japan as a natural experiment to test the theory. This tax reform introduced a consolidated taxation system (CTS). The CTS allows business groups to offset gains with losses across firms in the business groups. Thus, the CTS can mitigate disincentives in high-risk investments. We construct measures of investment risk using information on R&D. We estimate dynamic investment models with unique panel data of Japanese firms between 1994 and 2012. For identification, we use an IV strategy in a difference-in-differences framework or in a triple-differences framework. We provide evidence that the CTS increases R&D in line with Domar and Musgrave (1944). This finding suggests that mitigating tax asymmetries is an effective way to help encourage risk-taking. We also find evidence that the CTS encourages risk-sharing in business groups. These findings suggest that the asymmetries in the tax code have particularly important implications in countries where business groups are the prevailing organizational structures, because mitigating the tax asymmetries help encourage both risk-taking and risk-sharing.

The second chapter examines the relationship between stock market listing and corporate tax aggressiveness. Recent literature argues that agency conflicts between shareholders and managers reduce corporate tax aggressiveness. Although stock market listing is a fundamental source of the agency costs, a dearth of widely available data prevents researchers from investigating how monitoring from stock markets affects tax aggressiveness. We use unique panel data that cover both publicly-traded (listed) companies and privately-held (unlisted) companies in Japan. To mitigate endogeneity concerns about the choice to list stocks on public equity markets, we use

legal reforms in squeeze out as a quasi-natural experiment. We provide evidence that stock market listing decreases tax aggressiveness among companies whose ownership is concentrated. This result suggests that minority shareholders' option to sell stocks in public markets reduces managers' incentives to be tax aggressive. Our findings link a function of capital markets with public finance by demonstrating that financial developments can contribute to the effective collection of tax revenues.

The third chapter examines the relationship between dividend taxation and stock selling as well as payout policy. A 2011 tax reform in Japan raised the top marginal tax rates on dividend income from 10% to 43.6% among individual investors whose ownership ratio is in between 3% to 5%. This tax reform creates an incentive for these investors to sell stocks to restrict their ownership stakes below 3%. We find clear evidence of such ownership adjustments. 51.9% of these investors sell stocks on average. The percentage is 86.1% when the ownership ratio is in between 3% to 3.1%. We further exploit this tax reform to examine whether investors' tax preferences affect payout policy. In particular, those individual investors who retain stakes of at least 3% after the tax reform have an incentive to encourage firms to pay fewer dividends because dividends are less valuable for them. We find statistical evidence for this prediction. However, the impacts of taxes on dividend policy are not economically large.

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CHAPTER 1: Corporate tax asymmetries and R&D: Evidence from a tax reform for business groups in Japan

1. Introduction

At least since Domar and Musgrave (1944), it has been understood that the asymmetric tax treatment of gains and losses can affect corporate investments. In particular, the ability to deduct losses makes those losses less costly to a firm, which in turn should encourage additional risk-taking relative to a tax system that does not recognize those losses. In this paper, we provide new evidence on how taxes affect investments, making use of a change in the tax code in Japan.

A key component of this paper is business groups.[1] In the past, a limitation of the business group structures was that firms in business groups were treated as separate tax filing units; thus, taxable income was not calculated based on consolidated income across business group members. Although individual firms that run losses can carry those losses forward, they cannot receive an immediate tax refund. As a consequence, these firms face two tax penalties: loss carryforwards do not accrue interest and they can expire if unused for a certain period of time.

A Japanese consolidated taxation system (CTS) introduced in 2002 changed this tax framework. Adoption of the CTS is elective for business groups. If they adopt the CTS, corporate income tax is imposed on the aggregated taxable income across the parent companies and their wholly-owned subsidiaries. This additional deductibility lowers the probability of receiving the tax penalties. Thus, in line with Domar and Musgrave (1944), the CTS can mitigate distortions in investments.

We use information on R&D as investment risk measures.[2] For identification, we take a

[1] Business groups refer to a collection of a parent company and its subsidiaries under the parent's equity control. Pyramidal business groups are the predominant form of business organizations in Japan (Morck (2009)). For instance, Toyota Motor is the parent company of Toyota Group. Toyota Motor wholly owns Tokyo Toyota, a car dealer in the Tokyo area, and partly owns Hino Motors, a manufacturer of trucks and buses among various subsidiaries.

[2] There is ample evidence that supports the assertion of the riskiness of R&D. For example, the Data Book 2015 issued by the Japan Pharmaceutical Manufacturers Association documents that pharmaceutical companies can bring 0.003% of the compounds developed by them to market as a new medicine. A 2007 survey by the Japan Research Industries Association reports that the success rate of R&D projects that firms initiate from fundamental research is 11%. The survey is available at http://www.jria.or.jp/HP/H19_houkokusho/H19_SUMMARY_doukou.pdf (in Japanese). In Section 5.1., we provide evidence for this hypothesis with our data sets.

difference-in-differences approach or a triple-differences approach, using the introduction of the CTS as a natural experiment. First, we use a within-firm variation with unique panel data (Basic Survey of Japanese Business Structure and Activities). Second, the voluntary nature of CTS adoption divides business groups into the treatment group and the control group. These two differences allow us to use a difference-in-differences framework to test whether the CTS increases R&D. We also examine the impact of the CTS on an "R&D-Capex difference", which is R&D expenses minus capital expenditures, because R&D investments appear to involve higher risk than capital investments. An advantage of this triple-differences framework is that we can identify the impacts of the CTS after controlling for firm-year level investment opportunities. We estimate dynamic investment models because of the high adjustment costs of R&D (Hall (2002)).

Our empirical strategy seeks to address endogeneity concerns: the choice of whether to adopt the CTS is voluntary, which creates a selection problem. We take an instrumental variable approach to address this problem. We construct instruments so that they reflect future tax benefits from CTS adoption.[3] We use data of Japanese firms between 1994 and 2012. The data have distinctive advantages for studying R&D. For example, the data report information on physical capital investments in R&D and human capital investments in R&D, in addition to the firms' total R&D expenses. These unique data items allow us to test additional hypotheses as we will discuss below.

We find that the CTS increases both R&D-Capex difference and R&D expenses especially among parents. We also show that the CTS increases the aggregated R&D expenses across the business group members. This result suggests that the CTS relaxes the intertemporal budget constraints for the business groups. The impacts of the CTS are economically significant as well. The estimates from our main empirical model imply that the CTS increases business groups' R&D expenses-to-assets ratio by at least 0.429 percent points. A back-of-the-envelope calculation shows that the CTS reduces taxable income-to-assets ratio by 0.75 percent points. Thus, the impacts of the CTS on R&D correspond to 57.2% of the impacts of the CTS on consolidated taxable income.

The 2002 tax reform allows us further to test the risk-sharing hypothesis in business groups.[4]

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[3] For instance, one of the instruments is a dummy variable that takes one when the parents own tax losses and one of their wholly-owned subsidiaries reports positive income. Business groups can offset the parent's losses against the subsidiaries' gains only when they adopt the CTS.

[4] Khanna and Yafeh (2005) find that risk-sharing is a central motivation behind the existence of business groups.

The group loss offset provision of the CTS should be particularly effective to encourage risk-sharing, because the CTS can smooth income without incurring transaction costs to allocate resources in the business groups. First, we find that the CTS magnifies the disparity in R&D intensity between parents and their subsidiaries. An implication of this finding is that the CTS increases R&D either among parents or among subsidiaries to diversify risks from R&D. We also find that this risk-sharing effect of the CTS is especially clear for R&D human capital investments. This finding can be explained by knowledge spillover because it is more effective to concentrate knowledge in one unit in the business groups. Second, we provide evidence that the CTS tends to increase either R&D physical capital or R&D human capital. This evidence suggests that business groups engage in risk-sharing by increasing either factor of R&D investments. Thus, our findings suggest that the CTS encourages risk-sharing both in business groups and in asset types.

This paper contributes to the literature in several ways. First, we provide direct evidence that tax asymmetries discourage high-risk investments. The key difference with the previous literature is that we use natural experiments for identification.[5] Second, the public goods nature of R&D creates a gap between the social returns and the private returns.[6] We suggest that mitigating tax asymmetries is an effective way to encourage R&D. Third, our paper is related to the recent literature that emphasizes that patience regarding failure is an important factor to encourage high-risk activities.[7] Our paper suggests that tax systems that are impatient regarding losses can have adverse effects on risk-taking.[8] Fourth, various papers discuss the relationship between

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[5] Relevant studies include Auerbach (1986), Auerbach and Poterba (1987), Altshuler and Auerbach (1990), Devereux, Keen, and Schiantarelli (1994), Edgerton (2010), and Dreβler and Overesch (2013).

[6] Providing tax credits or subsidies is a common fiscal policy measure to fill this gap (Hall and Van Reenen (2000)).

[7] Manso (2011) theoretically shows that optimal contracts should not punish short-run failure to motivate innovation. Tian and Wang (2014) provide evidence that failure-tolerant venture capitalists spur innovation.

[8] Dreβler and Overesch (2013) explore the relationship between tax systems and German multinationals' investments. One of their focuses is the impact of business group taxation on capital expenditures. They find that group loss provisions increase capital expenditures of the multinationals' subsidiaries. Four differences between Dreβler and Overesch (2013) and our paper are worth emphasizing. First, they use capital expenditures as the investment risk measure, while we use data concerning R&D. Second, subsidiaries in their paper are located abroad, while we use data of domestic business groups. Third, the unit of analysis in their paper is subsidiaries, while our units of analysis include parents and the entire business groups as well. Fourth, they treat the existence of the business group taxation as given, while we use an experimental framework.

organizational structures and R&D.[9] We link business groups' R&D with taxation. Our findings suggest that the group loss offset provisions can be desirable because it encourages both risk-taking and risk-sharing. This policy proposal sheds new light on the wide-raging discussion on whether business groups are beneficial or harmful to the economy, by showing that the tax systems are a consideration in this discussion.[10] Fifth, we provide evidence that the CTS helps business groups restructure R&D human capital investments so that the CTS magnifies the spillover effects.[11] Our findings suggest that knowledge spillover plays important roles within firms in business groups.

The remaining sections are organized as follows. Section 2 provides background information. Section 3 explains the hypotheses and the research design. Section 4 describes the data. We conduct preliminary tests in Section 5. We show the estimation results in Section 6. Section 7 concludes.

2. Background information

We provide an overview of the Japanese corporate tax systems and the consolidated taxation system (CTS) in the first subsection. We explain costs and benefits of CTS adoption in the second subsection. In the third subsection, we briefly discuss the relationship between CTS adoption and endogeneity.

2.1. Tax systems in Japan and the CTS

Corporations in Japan pay both national corporate income taxes and local corporate taxes.[12] The

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[9] Seru (2014) shows that a conglomerate is an organizational form that is detrimental to innovation. In contrast, Belenzon and Berkovitz (2010) provide evidence that business group affiliation encourages innovation.

[10] Several papers find evidence on the positive aspects of business groups. Almeida, Kim, and Kim (2015) find that internal capital markets helped Korean business groups maintain their investment levels during the 1997 Asian Financial Crisis. Masulis, Pham, and Zein (2011) show that the business group structures emerge to complement underdeveloped capital markets. Gopalan, Nanda, and Seru (2007) document that business groups in India use intra-group loans to support group members. In contrast, several studies find evidence on negative aspects of the business groups structures in terms of tunneling, using data in India (Bertrand, Mehta, and Mullainathan (2002)) or data in Korea (Bae, Kang, and Kim (2002); Baek, Kang, and Lee (2006)). Onji (2013) examines business groups' participation decision in the Japanese CTS. The author shows that business groups' characteristics such as the amount of accumulated losses among parents are associated with the likelihood of CTS adoption.

[11] Knowledge spillover is often emphasized in the geographical context (Audretsch (1998)). Several papers examine the impacts of alliances on knowledge sharing (Gomes-Casseres, Hagedoorn, and Jaffe (2006); Jiang and Li (2009)).

[12] The national corporate income tax rates are 28.05% in 2012. The tax rates were 30% between 1999 and 2011, 34.5% in 1998, and 37.5% between 1990 and 1997. The local corporate tax rates are approximately 10% in 2012 in Tokyo.

Japanese corporate tax systems treat positive income and negative income asymmetrically like in many other countries. Corporations that earn positive income need to pay corporate income taxes. In contrast, corporations that report losses do not receive immediate tax refunds. Limited tax relief is available for the reported losses in the form of tax loss carryforwards. Under the tax system that is effective in 2012, firms can carry losses forward up to nine years.[13]

Tax penalties are typically discussed in the intertemporal context. Policy discussions in this context focus mostly on how governments design tax policy concerning loss carryforwards or loss carrybacks. In contrast, the CTS deals with loss offset in the cross sectional sense, because the CTS allows business groups to offset losses with gains across different corporations in the same year. From the economic perspectives, business groups undertake economic activities as one unit. From the tax perspectives, however, business groups were not treated as one unit. In other words, individual firms in the business groups are treated as separate tax filing units. Thus, there exists a loss-offset constraint among companies in the business groups.

The 2002 tax reform in Japan introduced the CTS.[14] The introduction of the CTS provides business groups an option to alleviate this loss-offset constraint. Adoption of the CTS is a voluntary

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The CTS does not apply to local corporate taxes, and the CTS applies only to the national corporate income taxes. Therefore, corporate taxes in this paper refer to national corporate income taxes. Our data sets cover year periods between 1994 and 2012. Thus, the corporate income tax rates are about 30% during the year periods of our interest. The tax rates are essentially flat with some special treatments for small and medium sized enterprises (SMEs). Firms whose paid-in capital are 100 million yen or below are classified as SMEs.

[13] The time span for loss carryforwards varied across time as follows: nine years from 2011 to 2014; seven years from 2004 to 2010; and five years up to 2003. The time span for loss carryforwards is shorter in Japan than in the U.S. (20 years). Therefore, we expect that tax penalties are severer in Japan than in the U.S. Cooper and Knittel (2010) show that the real value of tax losses erodes by more than one-half using tax return data in the U.S. Given the shorter time span for tax loss carryforwards in Japan, the value of tax loss carryforwards would depreciate more rapidly in Japan than in the U.S. Thus, tax penalties have the greater potential to affect managerial incentives in Japan.

[14] The CTS is unrelated to consolidated financial statements, and the CTS affects only tax incentives of business groups. In addition, The CTS does not change the limited liability constraints of individual firms in the business groups. One possibility is that business groups that adopt the CTS change their ownership structures so that they can obtain more benefits from the limited liability constraints. We will later provide evidence that we observe almost no changes in ownership structures of the business groups after they adopt the CTS. Therefore, the limited liability constraints do not appear to play an important role for our paper.

decision of the business groups. If the business groups adopt the CTS, corporate taxes are imposed on the consolidated income across the parents and their wholly-owned subsidiaries. The wholly-owned subsidiaries include both directly, wholly-owned subsidiaries and indirectly, wholly-owned subsidiaries.[15] The CTS is a domestic tax system. In other words, foreign subsidiaries are not included in the consolidated tax filing. All wholly-owned subsidiaries must be subject to the CTS if the business groups adopt the CTS. In other words, business groups cannot selectively include some wholly-owned subsidiaries in the consolidated tax filing. If business groups adopt the CTS, they cannot abolish the CTS in principal.[16] Therefore, the CTS adoption is an irreversible decision.

2.2. Cost of CTS adoption

CTS adoption has a clear tax advantage as long as there exist both corporations that report positive income and corporations that report negative income in the business groups.[17] However, not all business groups have adopted the CTS as we will describe in Section 4.2. The adoption rate is about 17% in 2012 in our sample. This observation suggests that there should exist costs associated with CTS adoption. A report issued by the Ministry of Economy, Trade and Industry surveys tax reform requests from various trade associations.[18] This report summarizes factors that provide disincentives for business groups to adopt the CTS.

The report reveals that the CTS is inflexible for business groups. Some trade associations

[15] Directly, wholly-owned subsidiaries refer to subsidiaries whose parent's ownership stakes are 100%. Indirectly, wholly-owned subsidiaries refer to a firm like Firm S in the following example. Suppose that 60% of the stakes of Firm S are owned by Firm P1, and the rest of 40% of the stakes are held by Firm P2. If Firm P1 wholly owns Firm P2, then Firm P1 wholly owns Firm S indirectly. In this case, Firm S is not a directly, wholly-owned subsidiary, but Firm S is an indirectly, wholly-owned subsidiary. If Firm P1 adopts the CTS, Firm S is included in the consolidated tax filing.

[16] Although the system allows the possibility of abolishment of the CTS under the approval of Commissioner of the National Tax Agency, being able to obtain an approval is the exception.

[17] To see this tax benefit in a simple example, suppose that a parent incurs losses of -80 billion yen and one of its wholly-owned subsidiaries reports gains of 100 billion yen. Assume that corporate tax rates are 30%. Without the CTS, the parent does not pay positive corporate taxes, and the wholly-owned subsidiaries pay 30 billion yen of taxes. This 30 billion yen represents the total tax burden for the business group. If the business group adopts the CTS, total tax payments are reduced to 6 billion yen, which is one fifth of the original tax payments. In this case, the business group can save 24 billion yen of corporate tax payments.

[18] The report is available at http://www.meti.go.jp/main/downloadfiles/zeisei24/youbou_all.pdf (in Japanese).

request that business groups should have the right to selectively include some wholly-owned subsidiaries in the consolidated tax filing. This is possibly because small wholly-owned subsidiaries can bring small tax benefits relative to the associated administrative costs for tax filing.[19] In contrast, some other industry groups request that the scope of the CTS should not be restricted to wholly-owned subsidiaries and that it should include some partly owned subsidiaries whose ownership stakes are over 80% or 66.6% as well.[20]

CTS adoption has ambiguous implications on the R&D tax credit.[21] The R&D tax credit applies to all firms. However, there is a difference in the calculation of the tax credit limit between CTS business groups and non-CTS business groups. When business groups adopt the CTS, the tax

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[19] Administrative costs to start and manage the CTS would not be negligible. Business groups might need to introduce internal administration systems across business group members. In addition, business groups might need to educate or hire workers who engage in tax matters, and they might need to make a contract with accounting firms. Furthermore, the restriction that the CTS applies only to national taxes is especially burdensome when the fiscal year differs between the parent and some of its wholly-owned subsidiaries. This is because these subsidiaries might need to prepare their own tax returns, tax returns for the CTS, and their financial statements separately in different months.

[20] Another disadvantage explained in this report is that business groups that adopt the CTS must abandon their wholly-owned subsidiaries' loss carryforwards that were recognized before CTS adoption. In other words, business groups can share their wholly-owned subsidiaries' losses only when the losses are recognized after the business groups adopt the CTS. This treatment is in contrast to the tax treatment of parents' loss carryforwards: parents' losses that are generated before CTS adoption can be used to offset losses across the group members after CTS adoption. A legal reform was implemented in 2010 so that business groups need not abandon at least some of the past tax losses of subsidiaries. However, business groups can only use these tax losses to offset the subsidiaries' own income. Business groups cannot use these losses to offset other business group members' income. In other words, the 2010 tax reform mitigated only the intertemporal constraint on loss offset, and this tax reform does not affect the loss offset across group members.

[21] The Japanese R&D tax credit system that is effective in 2012 consists of the following two systems. The first system is a volume system. This system allows firms to subtract 8-10% of R&D expenses from the corporate tax liabilities. The credit limit of the volume system is 20% of the tax liability. The second system is an incremental system. This system gives an additional tax incentive in R&D. The credit limit is 10% of the corporate income tax payments. Thus, the total credit limit is 30% of the corporate tax payments. Firms are eligible for an incremental credit if they increase R&D expenses compared to those in previous years. The calculation methods of the eligible expenses for the incremental system are relatively complicated. The details on the current Japanese R&D tax credit system is described, for example, in *2014 Global Survey of R&D Tax Incentives* issued by Deloitte.

credit limit is calculated as if the groups (parents and their wholly-owned subsidiaries) were one tax filing unit. This tax treatment implies that the aggregated tax credit limit can decrease when the tax burden is considerably reduced by the CTS. On the other hand, CTS adoption is advantageous in utilizing the R&D tax credit when the individual firms' tax credit limit is binding, because these firms can use the aggregated quota of R&D tax credit of the business groups. Thus, CTS adoption has ambiguous effects on the utilization of R&D tax credit.

2.3. Endogeneity concern and the CTS

The discussion in the previous subsections suggests that there are several potential sources of endogeneity concerns. First and most important, the voluntary nature of CTS adoption creates a selection problem. For example, parents might adopt the CTS because they anticipate unobservable, high-risk investment opportunities. This situation can cause an upward bias in OLS estimates when we regress investment risk measures on CTS adoption. Alternatively, parents might adopt the CTS because they anticipate substantial losses in the near future. This situation might cause a downward bias in the OLS estimates if firms suffer financial distress as a result of these losses.

Second, the CTS has several rules that can affect incentives to adopt the CTS as we discussed in the previous subsection. These factors might be a source of biases in OLS estimates. To mitigate these concerns, we use an IV strategy to identify the causal impacts of CTS adoption on investment behavior induced by the loss offset provision in a difference-in-differences framework or in a triple-differences framework. We discuss our research design in Section 3.2.

3. Hypotheses and estimation

We explain our hypotheses in the first subsection of this section. We present our research design in the second subsection. In this subsection, we discuss how we address the endogeneity associated with CTS adoption in detail.

3.1. Hypotheses

Before turning to our empirical strategy to address the endogeneity concerns, we highlight the hypotheses. Our prediction is based on the theory by Domar and Musgrave (1944) on how taxes affect risk-taking. CTS adoption allows business groups to use losses of one member company to offset gains elsewhere in the business groups. Therefore, CTS adoption reduces the possibility of receiving the tax penalties on losses, and thereby lowers the costs of risk-taking. Thus, business groups can shift towards more risk-taking after CTS adoption than before CTS adoption.

We use R&D as the risk measure of investment behavior.[22] The main analysis compares the impacts of the CTS on R&D expenses or on an "R&D-Capex difference". The R&D-Capex difference is defined by R&D expenses minus capital expenditures. There exists evidence that supports the assumption that the R&D investments involve higher risk than capital investments.[23] We test the validity of this assumption using our data sets in Section 5.1.

An advantage of the R&D-Capex difference as the risk measure over other risk measures[24] is that we can control for unobservable firm-year level investment opportunities in addition to the investment opportunities proxied by the market to book ratio. The availability of the firm-year level variation is helpful to identify the impacts of the CTS on investments, compared to the commonly used difference-in-differences framework in which we can separately include the firm fixed effect and the year fixed effect. We also use R&D expenses or capital expenditures as the regressand in the difference-in-differences framework. This regression allows us to test whether an increase in the R&D-Capex difference is caused by an increase in R&D expenses or a decrease in capital expenditures. We predict that the CTS increases both the R&D-Capex difference and R&D expenses, but the CTS does not have clear effects on capital expenditures.

In addition to total R&D expenses of individual firms, we use more detailed information of R&D with unique data sets described in the next section. The data cover information that is not disclosed on publicly available financial statements in Japan or in most other countries. We investigate the impacts of the CTS on capital expenditures that are used for R&D as well as the number of employees engaging in R&D. The former represents physical capital investments in R&D and the latter represents human capital investments in R&D. We expect that the CTS

[22] R&D also appears as investment risk measures in the literature (Coles, Daniel, and Naveen (2006); Kim and Lu (2011); Ryan and Wiggins (2002)).

[23] For example, Kothari, Laguerre, and Leone (2002) provide evidence that R&D investments are associated with greater earnings volatility than capital investments.

[24] Alternative risk measures used in the literature include the followings: leverage (Acharya, Amihud, and Litov (2011); Coles, Daniel, and Naveen (2006)); business focus (Coles, Daniel, and Naveen (2006)); presence of business losses (Cullen and Gordon (2007)); volatility of business earnings (John, Litov, and Yeung (2008)); diversifying acquisitions (Acharya, Amihud, and Litov (2011)); and an imputed measure constructed from the Fama-French three factor model (Armstring and Vashishtha (2012)).

increases both physical capital in R&D and human capital in R&D.

We also test the hypothesis that the CTS encourages risk-sharing among firms in the business groups. The literature documents that the central advantage of the business group structures is that firms in the business groups can engage in risk-sharing.[25] A relative strength of the CTS over other mutual insurance devices is that business groups need not incur transaction costs to shift income across firms in the business groups, because the CTS mechanically smooths income across business group members by offsetting gains with losses. Thus, we predict that the CTS encourages risk-sharing in business groups.

We use two measures of risk-sharing. The first measure is the disparity in R&D variables such as R&D expenses-to-assets ratio between parents and their subsidiaries. We regard that the CTS enhances risk-sharing if the CTS increases this disparity, because business groups concentrate high-risk activities either among the parents or among the subsidiaries to diversify risk from R&D. In this case, one unit in the business groups faces high earnings volatility and another unit faces low earnings volatility. This diversification is likely to lead to the situation that business groups offset gains with losses, which makes income stream relatively stable ex post. Second, we examine the differences in the impacts of the CTS between on R&D physical capital investments and on R&D human capital investments. We examine whether the CTS increases both of them or either of them. If we observe that the CTS increases only either of the R&D investments, we interpret that the business groups diversify risks in terms of the type of investments.

3.2. Research design

We use a difference-in-differences approach and a triple-differences approach. We first divide business groups into a treatment group and a control group. The treatment group consists of business groups that adopt the CTS, and the control group consist of business groups that do not adopt the CTS. The second difference comes from the panel structures of our data sets. In other words, we compare the impacts of the CTS on investments between before-CTS adoption and after-CTS adoption. The availability of a difference-in-differences framework is advantageous compared to other studies that examine the effects of tax incentives. This is because it is generally

[25] For example, Khanna and Yafeh (2005) show that business group affiliation reduces profit volatility. Gopalan, Nanda, and Seru (2007) show that business groups support distressed firms by utilizing internal capital markets through intra-group loans.

difficult to have a clear separation of a treatment group and a control group. Furthermore, we compare the impacts of the CTS on the R&D-Capex difference. This third comparison allows us to control for firm-year level investment opportunities. This comparison is not feasible in studies in which firm-fixed effects and year-fixed effects are included separately. There is a concern in our research design regarding the first difference: given that CTS adoption is an individual business group's choice, there exists a selection problem. We use an IV strategy to address the endogeneity. We discuss our identification strategy later in this subsection.

We have three units of analysis: parents, subsidiaries, and business groups. When the unit of analysis is business groups, we aggregate individual data items such as R&D expenses or assets across the parents, their partly-owned subsidiaries, and their wholly-owned subsidiaries. If we observe the impacts of the CTS on the total R&D of the business groups, a resource reallocation across business group members is not a major factor behind the impacts of the CTS on investments. In this case, we can argue that the CTS mitigates the loss offset constraint and in turn the investment distortions. Although we separately run regression using observations that consist of one of these three units in some analyses, business groups are the main unit of analysis in our paper.

We construct two dummy variables to capture the impacts of CTS adoption: a CTS adoption dummy variable and a CTS effective adoption dummy variable. When the unit of analysis is subsidiaries or business groups, the dummy variable reflects the adoption decision of their parent companies. The CTS adoption dummy is a variable that indicates whether the firm or its parent has adopted the CTS. This variable captures the basic idea that business groups change investment behavior after adopting the CTS.

Although the CTS adoption dummy appears to be a natural candidate of the regressor to examine the impacts of the CTS, there are two potential problems for using this variable. The first problem is that the CTS adoption dummy is directly related to the business group' decision. Therefore, use of this variable causes endogeneity concerns. Second, business groups that are going to adopt the CTS in the near future might begin to restructure their investment plans before they actually adopt the CTS. In particular, high-risk activities are likely to be preceded by CTS adoption because it can take several years before those activities turn out to be unsuccessful and experience losses. In other words, it is necessary to capture the potential impacts of CTS adoption.

We construct a CTS effective adoption dummy variable to capture the potential impacts of the

CTS. The CTS effective adoption dummy variable takes one in 2002 and afterwards if the firm or its parent adopts the CTS in any of the years between 2002 and 2012.[26] Therefore, the CTS effective adoption dummy can capture the potential impacts of the CTS on investments in addition to the impacts from the actual adoption of the CTS on investments. In other words, the CTS effective adoption dummy assumes that the CTS is potentially effective from 2002 for all business groups that adopt the CTS in any of the years between 2002 and 2012. The CTS effective adoption dummy is not completely related to individual firms' decisions to adopt the CTS. Therefore, we expect that the CTS effective adoption dummy is more exogenous than the CTS adoption dummy.

There remains a concern about endogeneity even when we use the CTS effective adoption dummy variable, because this variable reflects the business groups' decisions. Therefore, the separation of the treatment group and the control group based on the CTS effective adoption dummy can be subject to a selection problem.

We use an IV strategy to deal with the endogeneity. We construct instruments that reflect the likelihood of utilizing the loss offset provisions of the CTS as follows. We construct four dummy variables as instruments. Three of the instruments are dummy variables that take one if either of the following conditions are satisfied: i) the parents have positive income and at least one of their wholly-owned subsidiaries has past losses (PPSN dummy); ii) the parents have past losses and at least one of their wholly-owned subsidiaries has positive income (PNSP dummy); and iii) one of the business group's wholly-owned subsidiaries has positive income and one of the business group's wholly-owned subsidiaries has past losses (SPSN dummy). In addition to these three instruments, we construct the fourth instrument to capture the asymmetric treatment of past losses between parents and subsidiaries. We expect that parents' past losses themselves are determinants of CTS adoption because past losses incurred before CTS adoption can be carried forward only when those losses are reported by parents. Therefore, iv) the fourth instrument is a dummy variable that takes one when the parents have past losses (PN dummy). We expect that these four instruments are positively associated with CTS adoption.

We evaluate these four dummy variables in 2001 in our main regression. Alternatively, we evaluate them in 2000 or 1999 to check the sensitivity of our findings in Section 6.3.1. The

[26] For example, if the business group adopts the CTS in 2007, the CTS adoption dummy takes one in 2007 and afterwards, and the CTS effective adoption dummy takes one in 2002 and afterwards.

instruments take the value evaluated in 2001, which is zero or one, in 2002 and afterwards. In other words, all the instruments take zero up to 2001, and the instruments can take one in 2002 and afterwards. Note that the instruments constructed in this way do not explain the variation in the year of CTS adoption. This is a valid argument because the instruments are constructed so that they can explain the cross sectional variation in the control group and the treatment group to mitigate the selection problem. To construct the instruments, we use information of tax loss carryforwards for the parents' past losses. We use after-tax profits aggregated across the previous five years to calculate the subsidiaries' past losses because of a lack of data on tax losses at the subsidiaries' level. We assume that the subsidiaries own past losses if the aggregated after-tax profits are negative. We also classify that the firms have positive income when the firms' accumulated after-tax profits across the previous five years are positive.

Potential concerns for the IV strategy are the weak instruments and the violation of the exclusion restriction. We examine the strength of the instruments by regressing the CTS effective adoption dummy concerning the instruments. For the concern on the exclusion restriction, we conduct overidentification tests. The null of the test is that the overidentifying restrictions are valid. In addition, we conduct a falsification test to address the concern that the instruments might capture factors that directly affect future high-risk investments. We use the data periods before the introduction of the CTS to examine whether the instruments predict future R&D activities. Insignificant estimates of the coefficients on the instruments suggest that these variables are not correlated with future high-risk investments except through their interaction with the tax treatment. As an additional robustness check against the exclusion restriction, we exclude some year periods after CTS adoption or the introduction of the CTS. The idea behind this test is that if firms adopt the CTS because they anticipate negative or positive future investment opportunities, the investments should be made in a relatively short time horizon. Therefore, we exclude observations in the year of the CTS adoption or the CTS introduction (i.e., year 2002), as well as those observations one year after the CTS adoption or the CTS introduction.

We turn to the explanation of regressands that measure investment risk. One of the main regressands is an R&D-Capex difference-to-assets ratio. The R&D-Capex difference is defined by R&D expenses minus capital expenditures. An increase in the R&D-Capex difference implies that the observations take higher risk in investments. We also use R&D expenses-to-assets ratio or capital expenditures-to-assets ratio to test whether an increase in the R&D-Capex difference-to-assets ratio is caused by an increase in R&D expenses or a decrease in capital expenditures. Furthermore, we use other R&D related variables as the regressand, taking advantages of unique data sets described in the next section. Specifically, we use expenditures for fixed tangible assets used for R&D and the number of employees engaging in R&D. The former captures physical capital investments in R&D and the latter captures human capital investments in R&D. Each of them is a component of R&D expenses. Using this detailed information on R&D, we can evaluate whether the CTS helps encourage high-risk investments through an increase in R&D physical capital or an increase in R&D human capital. The number of employees engaging in R&D is divided by the lagged number of total employees to interpret this variable as R&D human capital investment ratio. Other investment variables are normalized by lagged assets.

We include cash flow and market to book ratio as control variables following the literature in the investment equation (Fazzari, Hubbard, and Petersen (1988)). Cash flow or internal finance can be a determinant of investments when firms face financial constraints.[27] The cash flow is normalized by lagged assets. Market-to-book ratio is defined by the sum of the firm's market value of stocks and total liabilities divided by lagged assets. This variable measures investment opportunities that are observable to market participants. When the unit of analysis is subsidiaries, we do not observe their market to book ratio because most of them are unlisted. Thus, we include their parents' market to book ratio in regression. Similarly, when the unit of analysis is the business groups, we use the parents' market to book ratio as the regressor. We also include firm fixed effect to use a within-firm variation. We include year dummies to control for year-level macro shocks.[28]

We use dynamic panel estimation techniques following the recent literature that recognizes high adjustment costs of R&D investments.[29] We use the one-step system estimator (Arellano and

[27] Brown, Martinsson, and Petersen (2012) report positive cash flow sensitivity of R&D investments. Our cash flow measure includes R&D expenses in addition to after-tax profits and depreciation to avoid a mechanical correlation between the R&D-Capex difference or R&D and the cash flow (Brown, Fazzari, and Petersen (2009)).

[28] When we instead include industry-year dummies, the estimates are almost the same with some signs of model misspecification based on Hansen test. Thus, we only include aggregated year dummies.

[29] For example, dynamic panel estimation is used in Bloom, Griffith, and Van Reenen (2002), Brown, Fazzari, and Petersen (2009), and Brown, Martinsson, and Petersen (2012). Survey articles also emphasize dynamic aspects of

Bover (1995); Blundell and Bond (1998)).[30] We instrument the lagged level dated t-3 and t-4 with differences and instruments the lagged differences dated t-2 with levels. We also use lagged level dated t-4 and t-5 for the differenced equation and the lagged differences dated t-3 for the level equation to examine the sensitivity of our findings to different GMM lag structures.[31] We instrument both cash flow and market to book ratio in the same way. We report Hansen test statistic for overidentifying restrictions to examine the joint validity of instruments. We also report difference-in-Hansen statistic for the four instruments to examine the validity of this subset of instruments. We use robust standard errors clustered at the firm level. The empirical specification is represented by equation (1) below when the unit of analysis is parents or business groups, and it is represented by equation (2) below when the unit of analysis is subsidiaries.

$$invest_{it} = \beta_1 invest_{it-1} + \beta_2 CTS_{it} + \beta_3 MB_{it} + \beta_4 CF_{it} + \alpha_i + u_t + \epsilon_{it} \quad (1)$$

$$\begin{aligned} invest_{it} = \beta_1 invest_{it-1} + \beta_2 CTS_{it} \times WS_{it} + \beta_3 CTS_{it} + \beta_4 WS_{it} \\ + \beta_5 MB_{it} + \beta_6 CF_{it} + \alpha_i + u_t + \epsilon_{it} \quad (2) \end{aligned}$$

where subscript i refers to firm, subscript t refers to year, invest represents investment variables (R&D expenses-to-asset ratio, R&D-Capex difference-to-assets ratio, capital expenditures-to-assets ratio, R&D physical capital-to-assets ratio, or R&D employees-to-employees ratio), CTS represents either the CTS adoption dummy or the CTS effective adoption dummy, MB represents market-to-book ratio, CF represents cash flow, WS represents a wholly-owned subsidiary dummy, α represents firm fixed effect, u represents year fixed effect, and ε represents error term.

We instrument CTS dummies with the four instruments as we have explained in this subsection.

R&D (Hall (2002)). On the other hand, several related papers use a static framework to study R&D or innovation (Seru (2014); Tian and Wang (2014)).

[30] The system GMM jointly estimates the original (i.e., level) equation and the differenced equation, instrumenting levels with differences and instrumenting differences with levels. This framework allows us to address the dynamic panel biases that stem from the inclusion of the lagged dependent variables.

[31] Use of this lag length is common in the literature that concerns that the error terms can be serially correlated of order one as well as too many instruments problems (Brown, Fazzari, and Petersen (2009); Brown, Martinsson, and Petersen (2012)).

When the unit of analysis is subsidiaries, we treat the ownership structures as exogenous. Therefore, we instrument CTS×WO with the interaction of the four instruments with the wholly-owned subsidiary dummy.[32]

4. Data

We describe our data sets in the first subsection of this section. In the second subsection, we present the summary statistics.

4.1. Description of the data

We use three data sets that cover information of Japanese corporations: the Basic Survey of Japanese Business Structure and Activities (BS data) collected annually by the Ministry of Economy, Trade, and Industry; Nikkei NEEDS FinancialQUEST (FQ data) collected by Nikkei Inc.; and hand-collected data concerning the CTS.

Our primary data source is the BS data. We use the data between 1994 and 2012.[33] The BS data have distinctive features for studying R&D. The data set covers publicly unavailable information about R&D activities. More specifically, the data report expenses for physical capital investments in R&D and the number of researchers firms hire. These pieces of information are not available in other widely used data sets such as Compustat.[34]

The BS data report the parent company's stock code if the observation has a parent. In other

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[32] One might be concerned if this assumption on the exogeneity of ownership structures is justifiable, because business groups can have incentives to adjust ownership stakes to obtain tax benefits from the CTS. However, our data do not provide evidence that the CTS affects ownership structures. For example in 2012, the ratio of wholly-owned subsidiaries to total subsidiaries is 69.9% among CTS business groups, and it is 69.5% among non-CTS business groups. Because these two numbers are close each other, this observation suggests that the decision to adopt the CTS is not related to ownership structures. In other words, ownership structures are exogenously determined in relation to CTS adoption. Thus, we maintain the assumption that ownership is exogenous throughout this paper.

[33] The target of the BS data is firms with over 50 employees and 30 million yen of paid-in capital. The Ministry directly sends questionnaires to firms. Therefore, the data can cover information that is not disclosed on publicly-available financial statements. In addition, the data cover both listed companies and unlisted companies. Data of unlisted firms are necessary for our study because wholly-owned subsidiaries cannot be listed companies.

[34] In addition, the BS data provide comprehensive information on R&D. According to the Survey of Research and Development conducted by the Japanese government, total R&D expenses spent by the corporate sector in 2012 are 12.2 trillion yen. Total R&D expenses recoded in the BS data are 10.4 trillion yen in 2012, which takes account of 85.2% of the total R&D expenses of this year. This high ratio helps us provide macro implications using the BS data.

words, the data sort out the parent-subsidiary relation based on the parents' stock code. The BS data also report information on the ownership ratio of the parent companies when the observation has a parent. A caveat is that the data report only direct ownership ratio of the parent company. This data limitation can cause an analytical problem because the CTS applies to both directly, wholly-owned subsidiaries and to indirectly, wholly-owned subsidiaries. This limitation in data on indirect ownership is problematic when the unit of analysis is subsidiaries. However, this classification does not cause a problem when the unit of analysis is the entire business groups because we aggregated variables across parents and all of their subsidiaries. Because our main focus is the impacts of the CTS on business groups' R&D, this potential misclassification in wholly-owned subsidiaries is not a major problem for our paper.

The BS data lack some financial information. The FQ data provide complementary information of listed firms about stock price, stock outstanding, and tax loss carryforwards. The FQ data also provide information concerning whether the parent has adopted the CTS. However, the FQ data do not tell in which year the parent adopted the CTS. We look into individual firms' financial statements to find the year of the individual firm's CTS adoption.

We describe the data screening process.[35] We remove unlisted parents because we use their market value of stocks in the main analysis. Note that we do not remove unlisted subsidiaries. We eliminate firms in the financial industries since their investment behavior appears to be largely different from that of non-financial firms. All variables are winsorized at the 1% level and the 99% level year by year.

4.2. Summary statistics

We report the number of each type of firms in Table 1. Individual firms are classified into either parents or subsidiaries. We also separately report the number of wholly-owned subsidiaries. Parents are observations that own at least one subsidiary, and that are not another firm's subsidiaries. In other words, parent companies in our analysis are located at the top of the business groups. Subsidiaries are observations that have parents that list their stocks. We define a CTS parent as a parent company that has adopted the CTS. We also define a CTS effective parent as a

[35] We treat missing values as follows. We replace missing values with zero when the firms report only either missing values or zero during the entire data periods. We replace missing values or zeros with the average of the previous period's value and the next period's value. We treat the remaining zeros as missing values.

parent company that adopts the CTS in any of the years between 2002 and 2012.[36] We use the terms CTS subsidiary, CTS effective subsidiary, CTS wholly-owned subsidiary, CTS effective wholly-owned subsidiary, CTS business group, and CTS effective business group in the same way.

Table 1 describes the number of each type of the firm-year observations. The first column reports the number of observations across the entire data periods. The second column reports the number of observations in 2002 and afterwards. Table 1 shows that average parents own 3.27 (40383/12356) subsidiaries and average CTS parents own 10.16 (7119/701) subsidiaries. This comparison shows that CTS business groups are larger than non-CTS business groups. This observation is consistent with an argument that it is more likely for large business groups to have opportunities to offset losses with gains, and therefore these business groups are more likely to adopt the CTS. This table also shows that there is a considerable cross sectional variation in CTS adoption. When we restrict observations to those after 2002, the ratio of CTS effective parents to total parents is 16.8% and that of CTS effective subsidiaries to subsidiaries is 44.2%. Thus, this table suggests that the tax reform provides an experimental environment where we have a treatment group and a control group.

Table 2 reports the summary statistics of individual variables by the unit of analysis.[37] The first row of the table shows that R&D expenses-to-assets ratio among parents is over twice as large as that among subsidiaries.[38] In contrast, subsidiaries are more capital intensive than parents. This finding about the comparison concerning capital expenditures between parents and subsidiaries is consistent with Masulis, Pham, and Zein (2011). In contrast, they provide evidence that subsidiaries face higher idiosyncratic risks. Their finding appears to be in contrast to ours, because we find that subsidiaries are less R&D intensive and therefore subsidiaries face lower idiosyncratic risks. The last row shows that parents are 19.3 times larger than subsidiaries on average. Therefore, parents are more R&D active than subsidiaries in the absolute sense as well as in the relative sense

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[36] For example, a parent that adopts the CTS in 2005 becomes a CTS parent in 2005, but the parent becomes a CTS effective parent in 2002, which is the year of the introduction of the CTS.

[37] The number of observations of R&D physical capital-to-assets ratio is smaller than that of others because the information of R&D physical capital is covered in the BS data only after 1997. Note also that the capital expenditures in our data set include only those in tangible assets, and they do not include expenditures in intangible assets.

[38] In addition, parents are more R&D intensive than subsidiaries according to other three measures of R&D: R&D-Capex difference; R&D physical capital; and R&D human capital.

adjusted by firm size. This observation also implies that business groups' total R&D intensity is mostly explained by the parents' R&D intensity. Thus, from the economic perspective, investigating the impacts of the CTS on R&D among parents is more important than investigating the impacts among subsidiaries.

5. Preliminary tests

The following subsections provide four preliminary results to support our assumptions. In the first subsection, we provide evidence that R&D is associated with high-risk. This is an essential assumption to exploit the CTS as a test of the theory by Domar and Musgrave (1944). In the second subsection, we provide descriptive statistics to demonstrate that it is likely that the loss offset provisions of the CTS affect the groups' total corporate tax liabilities. In other words, this subsection documents that the CTS can sufficiently mitigate the asymmetries in the tax code. In the third subsection, we provide evidence that the instruments explain the decision to adopt the CTS, by regressing the CTS effective adoption dummy on the instruments. In the fourth subsection, we provide evidence that the instruments do not violate the exclusion restriction in the framework of a falsification test. We use the data periods before the CTS introduction for this purpose.

5.1. The riskiness of R&D

This subsection tests our assumption that R&D involves high-risk. We follow estimation procedure by Kothari, Laguerre, and Leone (2002). The regressand is earnings volatility. This variable is defined by the standard deviation of after-tax ROA across the future five years. We include the log of assets and leverage as control variables following Kothari, Laguerre, and Leone (2002).[39] We also include the industry-year dummy to absorb the economic shocks that are common at the industry-year levels. We use robust standard errors clustered at the industry-year levels. The empirical specification is represented by

$$SD(Evol)_{it+1,t+5} = \beta_1 invest_{it} + \beta_2 lnast_{it} + \beta_3 lev_{it} + u_{jt} + \epsilon_{it},$$

[39] A rationale for including these two variables is that they can capture financing environments for firms. For example, large, less-leveraged firms can have better access to external capital markets, which in turn can reduce earnings volatility. Kothari, Laguerre, and Leone (2002) use the log of market capitalization to control for firm size. We use the log of assets instead because our data include unlisted companies.

where subscript i refers to firm, subscript t refers to year, subscript j refers to industry, SD(Evol) refers to future earnings volatility, invest represents investment variables in percentage (R&D expenses-to-assets ratio, R&D-Capex difference-to-assets ratio, capital expenditures-to-assets ratio, R&D physical capital-to-assets ratio, or R&D employees-to-employees ratio), lnast represents the natural log of assets, lev represents leverage, u represents industry-year fixed effect, and ε represents error term.

Table 3 reports the estimation results. The unit of analysis is business groups. Each column uses a different investment ratio as the regressor. This table shows that both the R&D expenses-to-assets ratio coefficients and the R&D-Capex difference-to-assets ratio coefficients are positive and significant. This result supports our premise that we can use these two variable as high-risk investment measures. In contrast, the capital expenditures-to-assets ratio coefficients are negative. This finding suggests that capital expenditures are not appropriate as investment risk measures.

Both R&D physical capital-to-assets ratio coefficients and R&D employees-to-employees ratio coefficients are positive and significant as well. In terms of the economic significance, there exists a difference between them. Economic significance measured by the impact of one standard deviation change in R&D human capital investments is about twice as large as that in R&D physical capital investments. This result suggests that R&D human capital investments involve higher risk than R&D physical capital investments. This argument appears to be plausible given that hiring high-skilled workers require considerable commitments regarding wage payments as fixed costs, which in turn lead to higher earnings volatility.

5.2. Loss offset provisions and corporate tax liabilities

The CTS is a tax system that allows loss offsetting in business groups. It might be questionable, however, whether the loss offset provision can sufficiently reduce consolidated income so that the CTS can affect corporate risk-taking.[40]

According to tax statistics issued by the National Tax Agency, the consolidated taxable income in 2012 is 5.21 trillion yen across all the business groups that have adopted the CTS.[41] If the

[40] For example, one might be concerned that parents are considerably larger than subsidiaries in firm size, and therefore the absolute value of income between these two units is totally different. In this case, the impacts of loss offset across the parent and the subsidiaries is limited.

[41] The statistics are available at https://www.nta.go.jp/kohyo/press/press/2013/hojin_shinkoku/02.htm (in Japanese).

business groups were to file tax returns individually, the taxable income is 6.82 trillion yen according to the statistics. Therefore, the CTS reduces taxable income by 23.6% in 2012. Similarly, the CTS reduces taxable income by 39.2% (3.04 divided by 5.00) in 2011.

In our data sets, the average pre-tax ROA is 2.55% before the introduction of the CTS.[42] Therefore, the reduction in taxable income from the CTS-to-assets ratio is 0.602 (2.55×0.236) in 2012, and it is one (2.55×0.392) in 2011. The average of these two numbers is 0.75. We use this value of 0.75% for a back-of-the-envelope calculation to provide an economic interpretation concering estimation results in the next section. For example, if the coefficients of R&D expenses-to-assets ratio are close to 0.75, the reduction in taxable income of the CTS is almost identical to the increase in R&D expenses by the CTS.[43]

5.3. The instruments and CTS adoption

This subsection examines whether the instruments explain the cross sectional variation of the business groups' decision to adopt the CTS. In other words, this section explores whether the instruments can effectively divide firms into the treatment group and the control group. We use the Probit model to examine the relationship between the CTS effective dummy and the four instruments. We restrict our observations in 2002 to test whether the instruments explain the cross sectional variation of CTS adoption. We use robust standard errors.

$$CTS_i = \beta_1 PPSN_i + \beta_2 PNSP_i + \beta_3 SNSP_i + \beta_4 PN_i + \epsilon_i$$

where subscript i refers to firm, CTS represents the CTS effective adoption dummy, PPSN represents a dummy variable that takes one if the parents have positive income and one of their wholly-owned subsidiaries has past losses, PNSP represents a dummy variable that takes one if the parents have past losses and one of their wholly-owned subsidiaries has positive income, SNSP

[42] We replace negative ROA with zero in this calculation of pre-tax ROA because the CTS reduces taxable income when the business groups report positive income.

[43] Suppose that the CTS reduces taxable income by100. This business group can receive a tax refund of 30 because of the CTS when the tax rate is 30%. If this business group spends 100 for R&D and this project turns out to be a failure ex post, the ex post tax refund from the CTS is 30. In this case, we can interpret that the CTS works as a subsidy for R&D.

represents a dummy variable that takes one if one of the business group's wholly-owned subsidiaries has positive income and one of the business group's wholly-owned subsidiaries has past losses, PN represents a dummy variable that takes one if the parents have past losses, and ε represents error term.

Table 4 reports the estimation results. Columns (1) – (4) include each instrument separately, and column (5) includes all the four instruments simultaneously. Column (1) – (4) show that all the coefficients are positive and statistically significant at the 1% level. Column (5) shows that the statistical significance disappears for the PPSN dummy and the PNSP dummy, but these four coefficients are jointly significant with the F-statistics of 64.35. Therefore, the instruments are sufficiently strong to explain the variation in the decision to adopt the CTS, which enables us to use an experimental research design.

5.4. Evidence that the instruments do not violate the exclusion restriction

We turn to a discussion on the exclusion restriction. If the instruments capture some fundamental factors that directly affect future high-risk investments, the instruments are invalid. We conduct a falsification test by using the data periods before the introduction of the CTS. As long as business groups do not anticipate the legislation of the CTS, we can isolate the relationship between the instruments and future high-risk investments using these data periods. Therefore, this estimation works as a test to examine the exclusion restriction if this assumption is supported.

We first provide descriptive evidence that it is unlikely that business groups anticipated the introduction of the CTS in some years before its legislation. We cite several newspaper articles from the Nikkei, which is a leading economic newspaper in Japan. The Nikkei reported on December 11, 1999 that the Japanese Government Tax Commission decided that they would not introduce the CTS before 2002. The Nikkei on November 22, 2001 reported an interview with the Minister of Finance that the Japanese government would aim to introduce the CTS in 2003. However, the Nikkei on November 27, 2001 reported that the Minister of Finance retracted his previous statement, and stated that the Japanese government might introduce the CTS in 2002. The Nikkei on December 15, 2001 reported that the ruling party decided to introduce the CTS in 2002. These statements demonstrate that it was difficult for business groups to anticipate CTS legislation before 2002. Because the legislation in 2002 was approved just before 2002, we can isolate the direct impacts of the instruments on high-risk investments using the data periods before CTS legislation in this framework of falsification test.

We use data periods up to 2001 for this test. The empirical specification basically follows model (1) in Section 3.2. The difference with this specification is that we replace the CTS dummy with the four instruments. The empirical specification is represented by

$$invest_{it} = \beta_1 invest_{it-1} + \beta_2 PPSN_{it-1} + \beta_3 PNSP_{it-1} + \beta_4 SNSP_{it-1} + \beta_5 PN_{it-1} + \beta_6 MB_{it} + \beta_7 CF_{it} + \alpha_i + u_t + \epsilon_{it}$$

where subscript i refers to firm, subscript t refers to year, invest represents investment variables (R&D expenses-to-asset ratio or R&D-Capex difference-to-assets ratio), PPSN represents a dummy variable that takes one if the parents have positive income and one of their wholly-owned subsidiaries has past losses, PNSP represents a dummy variable that takes one if the parents have past losses and one of their wholly-owned subsidiaries has positive income, SNSP represents a dummy variable that takes one if one of the business group's wholly-owned subsidiaries has positive income and one of the business group's wholly-owned subsidiaries has past losses, PN represents a dummy variable that takes one if the parents have past losses, MB represents market-to-book ratio, CF represents cash flow, α represents firm fixed effect, u represents year fixed effect, and ε represents error term.[44]

Table 5 shows the estimation results. The unit of analysis is business groups. The regressand is R&D expenses-to-assets ratio in columns (1) – (2), and it is R&D-Capex difference-to-assets ratio in columns (3) – (4). The odd numbered models and the even numbered models are different in terms of the GMM lag length.

All the coefficients on the instruments are insignificant when the regressand is R&D expenses-to-assets ratio. In addition, the test for joint significance of the instruments provides evidence that the instruments do not jointly affect R&D, either. These results mitigate our concern on endogeneity in our main analysis. In column (3), the lagged PNSP dummy coefficient is statistically significant. However, the statistical significance disappears in column (4). These results from Table 5 provide support that the instruments are valid. We further discuss the validity

[44] For parents' past losses, we use accumulated accounting losses across the past five years instead of tax loss carryforwards due to a lack of the information data before 1999.

of the instruments in Section 6.3.

6. Result

This section presents the estimation results. The first two subsections respectively test whether the CTS encourages risk-taking and risk-sharing. In the third subsection, we conduct tests to provide further evidence that endogeneity does not cause a bias in the estimates. We also discuss the relationship between the CTS and R&D tax credit in this third subsection.

6.1. Tax asymmetries and risk-taking

6.1.1. R&D expenses

Table 6 shows the estimation results when the regressand is the R&D expenses-to-assets ratio. The units of analysis of Panels A, B, and C are parents, subsidiaries, and business groups, respectively. Columns (1) – (4) use the CTS adoption dummy as the main regressor, and columns (5) – (8) use the CTS effective adoption dummy as the main regressor. The odd numbered models do not instrument the CTS dummies, and the even numbered models use the instruments for the CTS dummies.

Panels A and C of Table 6 show that the coefficients on both the CTS adoption dummy and the CTS effective adoption dummy are positive and statistically significant among parent companies and business groups.[45] This result implies that the CTS increases high-risk investments measured by R&D.

In Panel B, we observe positive coefficients of the CTS dummy among subsidiaries as well. However, we do not observe differences in the impacts between partly-owned subsidiaries and wholly-owned subsidiaries in most empirical specifications. This result appears to be inconsistent with the institutional details of the CTS, because the CTS applies to wholly-owned subsidiaries but does not apply to partly-owned subsidiaries.[46] Note that if we include only the CTS dummies without the interaction term of the CTS dummies with the wholly-owned subsidiary dummy, we obtain positive and significant coefficients on the CTS dummies. Therefore, we find positive impacts of the CTS on R&D among subsidiaries as a whole.

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[45] The CTS effective adoption dummy coefficients are significant in both Panels A and C. This result suggests that business groups utilize the potential availability of the CTS as well as the actual loss offset effect of the CTS.

[46] This result might be attributable to the data limitation that we do not make a distinction between partly-owned subsidiaries and indirectly, wholly-owned subsidiaries.

The magnitude of the CTS dummy coefficients are economically significant as well.[47] The smallest coefficients in Panel C when we instrument the CTS dummy are 0.429 in column (4).[48] This magnitude equals to 57.2% of the reduction in taxable income of the CTS-to-assets ratio (0.75%). This argument implies that mitigating tax asymmetries is an effective fiscal policy measures to encourage R&D.

In all the columns in Table 6, the lagged R&D expenses-to-assets ratio coefficients are positive and significant. This finding suggests that it is important to consider adjustment costs of R&D to avoid an omitted variable bias as discussed by Hall (2002). We find positive cash flow sensitivity of R&D in all the columns. This is consistent with the finding by Brown, Martinsson, and Petersen (2012) that R&D investments are susceptible to financial constraints. Market to book ratio coefficients are positive and significant in some columns among parents, but the results are sensitive to the GMM lag structures.[49] Mixed evidence about the impacts of market to book on R&D is also reported in Brown, Martinsson, and Petersen (2012).[50]

6.1.2. R&D-Capex difference

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[47] Note that the magnitude of the CTS dummy coefficients in Panels A and C are close each other. This observation suggests that the impacts of the CTS are mostly determined by the impacts at the parents' level. This result appears to be intuitive given that parents are considerably larger than subsidiaries, and therefore the impacts of the CTS among parents are a dominant factor to consider the impacts among business groups.

[48] The magnitude of the coefficients is smaller when we do not instrument the CTS dummies. For example, in Panel C, the CTS dummy coefficient is 0.212 in column (5) and it is 0.675 in column (6). This might be a consequence of the attenuation bias in OLS estimates because of measurement errors. A potential source of the measurement errors could be that business groups adopt the CTS because of a motivation that is not necessarily related to the loss offset provisions of the CTS such as relatively low administrative costs for filing consolidated tax returns.

[49] This unclear result on market to book ratio might be because it is not an adequate measure for investments in intangible assets. Alternatively, this might be a consequence of mismeasurement in investment equations (Almeida, Campello, and Galvo (2010)).

[50] We turn to a discussion on diagnostic tests. Although the tests do not support that all the empirical models are correctly specified, we argue that it does not cause a bias in estimates. For example, the diagnostic tests in column (8) across all the three panels in Table 6 report that both the Hansen test and the difference-in-Hansen test do not reject the validity of the overidentification restrictions. In addition, the test for autocorrelation does not reject the null of no third-order autocorrelation. Although we detect signs of model misspecification in some models, we argue that it is not a critical problem, because the CTS dummy coefficients are broadly comparable across all the columns when we instrument the CTS dummies.

The first three columns of Table 7 report the estimation results when the regressand is the R&D-Capex difference-to-assets ratio. We only report the estimation results when we instrument CTS dummies and use the CTS effective adoption dummy as the main regressor. Columns (1) – (3) of this table show that all the CTS dummy coefficients are positive and significant.[51] These results provide an additional support for our predication that the CTS encourages risk-taking among business groups, by showing that firm-year level investment opportunities do not affect our findings in Table 6.[52]

The lagged dependent variable affects its current level of the R&D-Capex difference in all these three columns. Thus, the dynamic specification is appropriate. Neither the cash flow nor the market to book ratio has robust impacts on the R&D-Capex difference among parents or business groups. Among subsidiaries, cash flow is negatively associated with the R&D-Capex difference. These findings can be explained by the argument that cash flow increases both R&D and capital expenditures, but the relative impacts on these two types of investments are heterogeneous among different units of analysis. We discuss this possibility in the next subsection.

6.1.3. Capital expenditures

Columns (4) – (6) of Table 7 show the estimation results when the regressand is the capital expenditures-to-assets ratio. The table shows that none of the CTS dummy coefficients are positive and significant.[53] This result provides support that the CTS affects only high-risk activities, given

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[51] In column (2), we do not observe significant differences in the impacts of the CTS between partly-owned subsidiaries and wholly-owned subsidiaries.

[52] Our estimation shows that the magnitude of CTS dummy coefficients is considerably larger in Table 7 than in Table 6. When the unit of analysis is business groups, the magnitude of the CTS effective adoption dummy coefficient in column (3) of Table 7 is 2.48 times larger than that in column (6) of Table 6. This difference would reflect the difference in standard deviation of each variable. The standard deviation of R&D expenses-to-assets ratio is 2.22 and that of R&D-Capex difference-to-assets ratio is 4.16 among business groups. Therefore, the latter is 1.87 times larger than the former. Another possibility is that the CTS increases R&D and decreases capital expenditures at the same time. We provide support for this second argument in the next subsection.

[53] Although the CTS dummy coefficients in columns (4) - (6) are insignificant, the coefficients are negative. This finding provide an explanation concerning the large impacts of the CTS on the R&D-Capex difference, because the CTS can increase this difference by decreasing capital expenditures. In column (5), the coefficient of the interaction term of the CTS dummy with the wholly-owned dummy is negative and significant at the 10% level. An explanation of this finding is that subsidiaries use the budgets for capital expenditures to increase their R&D expenses.

that capital expenditures are not associated with earnings volatility in Table 3.

We find that lagged capital expenditures affect the current level of capital expenditures. The impacts of the lagged dependent variable are generally smaller in capital expenditures than in R&D expenses.[54] This comparison suggests that adjustment costs are more important considerations in R&D investments than capital investments. The persistence in R&D across time is likely to be caused by the fact that a considerable portion of R&D expenses are used for wage payments for researchers. According to the Survey of Research and Development conducted by the Statistics Bureau of Japan in 2012, 42.4% of R&D expenses are used for labor costs. Because it is relatively difficult to frequently change wage payments or the number of employees engaging in R&D, R&D activities involve high adjustment costs. We provide support for this argument in the next section.[55]

6.1.4. R&D physical capital and R&D human capital

Columns (1) – (3) and (4) – (6) of Table 8 respectively report the estimation results when the regressand is the R&D physical capital-to-assets ratio or the R&D employees-to-employees ratio. Among parents, the CTS adoption has significant impacts on both of these two types of the R&D investments. Among business groups, the impacts of the CTS on R&D physical capital are statistically clear relative to those on R&D human capital. Among subsidiaries, the impacts of the CTS on both of the R&D investments are not clear. These results demonstrate that the impacts of the CTS on these two types of the R&D investments are different among different units of analysis. We further examine this aspect of the CTS in Section 6.2.

Alternatively, business groups might transfer the subsidiaries' budgets for capital expenditures to their parents so that the parents can spend more expenses for R&D. This resource reallocation can be interpreted as evidence that business groups utilize internal capital markets in the business groups. This interpretation is consistent with the recent findings that business groups transfer resources in the business groups for investments (Almeida, Kim, and Kim (2015)).

[54] For example, the lagged dependent variable coefficient is 0.808 in column (6) of Panel C of Table 6, and it is 0.450 in column (6) of Table 7.

[55] Table 7 shows that cash flow is positively associated with capital expenditures. The coefficient is particularly large among subsidiaries. This finding can explain that cash flow coefficient is negative in column (2) of Table 7. If the positive impacts of cash flow on capital expenditures are larger than that on R&D expenses, we observe negative coefficients on the R&D-Capex difference. In Table 7, there is a concern in the Hansen test statistics, because the test rejects the validity of the overidentification restrictions. Given that the main regressand in our paper is R&D expenses, we argue that this potential model misspecification does not affect our key findings.

Another difference between Columns (1) – (3) and (4) – (6) is the magnitude of the lagged dependent variable coefficients. Among business groups, the coefficient of lagged R&D physical capital is 0.471 and that of lagged R&D human capital is 0.907. This contrast suggests that R&D human capital is more persistent than R&D physical capital. This argument is consistent with our argument that R&D human capital involves high adjustment costs. This finding provides rationale for the argument by Hall (2002) that R&D investments are persistent, given that a half of R&D expenses typically consists of those for human capital.

6.2. Tax asymmetries and risk-sharing

The previous subsection examines the impacts of the CTS on risk-taking based on the theory by Domar and Musgrave (1944). In this subsection, we test the possibility that the CTS enhances risk-sharing. The first subsection examines risk-sharing among business group members. The second subsection explores risk-sharing by asset type.

6.2.1. Risk-sharing among business group members

In this subsection, we examine whether the CTS has heterogeneous impacts on risk-taking among business group members, which can be interpreted as risk-sharing in business groups. Specifically, we expect that the CTS has stronger impacts in one unit of business groups to diversity risk from R&D. Thus, we estimate model (1) using the disparity in investment ratio between the parents and their subsidiaries as the regressand. A larger disparity implies that business groups diversify risk.

Table 9 shows the estimation results. The unit of analysis is business groups. Column (1) shows that the CTS increases the disparity between R&D expenses-to-assets ratio between parents and subsidiaries. This finding supports that the CTS encourages business groups to share risks incurred through R&D. In contrast, column (2) shows that the CTS does not necessarily encourage risk-sharing measured by the R&D-Capex difference. As column (3) shows, this result is caused by the effect of the CTS narrowing the difference in capital expenditures-to-assets ratio between parents and their subsidiaries.

Columns (4) - (5) show a contrasting result. Column (5) provides clear evidence that the CTS widens the disparity in R&D human capital, while column (4) shows that the impacts on the disparity in R&D physical capital are not statistically clear. There are several possible explanations behind this difference. First, from Table 3, R&D human capital involves higher-risk than R&D physical capital. Therefore, the CTS can have stronger effects on the former than on the latter, because this change in investment policy allows business groups to have more opportunities to offset losses with gains. Second, this finding can be explained by the spillover effects of knowledge. Because knowledge spillover is largest within firms (Gomes-Casseres, Hagedoorn, and Jaffe (2006)), it is more effective for business groups to concentrate human capital in single units within the business groups. This factor leads to a wider disparity in R&D employees-to-employees ratio.

6.2.2. Risk-sharing by asset types

We examine whether the CTS encourages risk-sharing by asset types in this subsection. Our test takes advantages of time-series correlation of R&D physical capital investments and R&D human capital investments. Suppose that when one of them increases. If another of them also increases, we observe a positive time-series correlation between these two types of investments. On the other hand, if another type of investment decreases or it is unchanged, we observe a weakly negative correlation. We interpret the negative correlation as evidence of risk-sharing. We use year of 2002 as the base year. For example, suppose that the average value of the R&D physical capital-to-assets ratio across the year periods up to 2001 is smaller than the average of the R&D physical capital-to-assets ratio across the year periods after 2001, we make an interpretation that the business groups increase R&D physical capital-to-assets ratio.

Columns (1) - (2) of Table 10 report the estimation results when the regressand is R&D physical capital-to-assets ratio. Column (1) shows the results when the business groups increase the R&D employees-to-employees ratio. The CTS dummy coefficient is not significant. Column (2) shows the results when business groups increase the R&D employees-to-employees ratio. The CTS dummy coefficient is statistically significant. These results suggest that business groups engage in risk-sharing by the asset types. Columns (3) - (4) of Table 10 confirms this result when the regressand is the R&D employees-to-employees ratio. We observe a positive coefficient of the CTS dummy in column (4) but not in column (3). This result also supports that the CTS encourages risk-sharing by asset types.

6.3. Robustness and R&D tax credit

A central concern of our research design is regarding the choice of the instruments for the CTS dummies. In the first subsection, we provide an additional support for our research design. We run regression excluding several year periods after the adoption of the CTS or the introduction of the CTS. In addition, we use years that are different from 2001 to evaluate the instruments. In the second subsection, we discuss the relationship between the CTS and R&D tax credit.

6.3.1. Robustness

Table 11 shows the estimation results when we exclude some year periods. The regressand is R&D expenses-to-assets ratio. We report only the coefficients of the CTS dummies for brevity. The first row represents the original model from Table 6.[56] The second row represents models that exclude the year of CTS adoption (columns (1) and (2)) or the year of the CTS introduction (columns (3) and (4)). The third row represents models that exclude one more year after the CTS adoption or the CTS introduction as well.

Table 11 demonstrates that all the coefficients are statistically significant. In addition, the magnitude of the coefficients is broadly comparable across all the models: the minimum coefficient is 0.429 and the maximum coefficient is 0.837. This finding from Table 11 supports that it is unlikely that unobservable high-risk investment opportunities are the factor that causes the correlation between the CTS and R&D, which mitigates our concern in endogeneity.

Table 12 reports the estimation results when we use another year as the base year to evaluate the instruments. Like Table 11, we only report coefficients of CTS dummies. The first row represents the original model from Table 6 where we construct instruments using information evaluated in 2001. The second row and the third row respectively use 2000 or 1999 as the year to evaluate the instruments.

Table 12 shows that all the coefficients are statistically significant. It is noteworthy that the magnitude of the coefficients are smaller when we use older lag. The smallest coefficient of R&D expenses-to-assets ratio is 0.289 in column (2). Even this smallest coefficient amounts to 38.5% of the reduction in taxable income from the CTS-to-assets ratio (0.75%). Therefore, we obtain robust evidence that the CTS increases R&D and the impacts are economically significant.

6.3.2. R&D tax credit

A potential concern in our estimation results is that these findings are not caused by the CTS but they are attributable to the R&D tax credits. This concern is mitigated by the tax design where the R&D tax credit is applied to all firms and we include year-fixed effect in the regression. Therefore, we need not worry about the influence of the R&D tax credit as long as its impacts are homogenous

[56] Columns (2), (4), (6), and (8) in Panel C of Table 6 respectively correspond to columns (1), (2), (3), and (4) in Table 11.

across firms in the same year. However, this may not be a valid argument because CTS adoption affects the calculation of the tax credit limit. As previously discussed, when business groups adopt the CTS, the tax credit limit is calculated based on the consolidated tax payments across the parents and their wholly-owned subsidiaries. Thus, CTS adoption can have impacts that are interacted with the R&D tax credits. In this subsection, we examine this issue.

The R&D tax credit system in Japan exhibits a time-series variation. However, between 2006 and 2012, the credit rate of both the incremental system and the volume system are unchanged. In contrast, the credit limit experienced changes during these year periods. The credit limit is 20% of corporate tax liabilities in 2006-2007, 30% in 2008 and 2012, and 40% in 2009-2011. Since only credit limit is affected by CTS adoption, we can examine whether the CTS has interacted impacts with the R&D tax credit by comparing the impacts of the CTS across years. If this interacted impact is observed, the order of its magnitude should be as follows: 2009-2011; 2008 and 2012; and 2006-2007.

We test this prediction by including interaction terms of the CTS dummy variables with a credit limit 20% dummy, a credit limit 30% dummy, and a credit limit 40% dummy, where each of the credit limit dummies takes one during the relevant year periods. We instrument each of the interaction terms by the interaction of the four instruments with the relevant year period dummies. The empirical specification is represented by the following equation.

$$
\begin{aligned}
invest_{it} = \beta_1 invest_{it-1} + \beta_2 CTS_{it} + \beta_3 CTS_{it} \times CL20_t + \beta_4 CTS_{it} \times CL30_t \\
+\beta_5 CTS_{it} \times CL40_t + \beta_6 MB_{it} + \beta_7 CF_{it} + \alpha_i + u_t + \epsilon_{it}
\end{aligned}
$$

where subscript i refers to firm, subscript t refers to year, invest represents R&D expenses-to-assets ratio, CTS represents the CTS effective adoption dummy, CL20-CL40 represent dummy variables that take one in the year periods when the credit limit is the number indicated after CL (for example 20), MB represents market-to-book ratio, CF represents cash flow, α represents firm fixed effect, u represents year fixed effect, and ε represents error term.

Table 13 reports the estimation results. Most of the coefficients of the interaction terms are not different from the base coefficients of the CTS effective dummy. This result suggests that the different treatment in the R&D tax credit between CTS business groups and non-CTS business groups do not affect R&D. The interaction term with the credit limit of 40% dummy coefficients are smallest compared to other interaction terms. A reason behind this finding may be that the CTS considerably reduces the consolidated corporate tax liabilities of the business groups. As a result, the credit limit of the business groups is reduced. These findings suggest that the loss offset provisions rather than R&D tax credit are the reason behind the impacts of the CTS on R&D.

7. Conclusion

In this paper, we test whether mitigating corporate tax asymmetries reduces disincentives in high-risk investments. Although considerable research has been devoted to the examination of theoretical aspects, few studies provide direct evidence for this theory. We use the Japanese consolidated taxation system (CTS) in 2002 as a natural experiment. The CTS provides business groups the rights to offset losses with gains in the business groups, which in turn can mitigate the tax asymmetries. Thus, the CTS can reduce investment distortions in high-risk activities.

We use a difference-in-differences approach and a triple-differences approach for identification. We also instrument the decision to adopt the CTS based on individual business groups' past information that captures potential tax benefits from adopting the CTS. We provide evidence that the CTS increases high-risk investments measured by information on R&D. This finding is consistent with the theoretical predictions since Domar and Musgrave (1944).

We use this tax reform to further test the prediction that the CTS enhances risk-sharing among the business group members. We first find that the CTS widens the disparity in R&D between the parents and their subsidiaries. We also find that the CTS tends to increase either R&D physical capital investments or R&D human capital investments. We interpret this finding as evidence that business groups engage in risk-sharing, taking advantages of the loss offset provisions of the CTS.

Our findings suggest that mitigating corporate tax asymmetries is an effective policy to encourage R&D. This proposal provides a new insight on the policy debate concerning how governments can encourage R&D. Our findings also provide a rationale for the group loss offset provisions because these provisions can encourage both risk-taking and risk-sharing. Dreβler and Overesch (2013) report that 22 of the 41 countries in their data sets introduced business group taxation in 1996, and the number increased to 27 in 2007. Thus, our findings have broad implications on policy discussions about business group taxation in other countries as well.

Table 1

The number of observations

This table reports the number of observations of each type of firms. The data periods are between 1994 and 2012. We report the total number of observations and those observations after 2002 separately. Parents are observations that own at least one subsidiary, and that are not another firm's subsidiaries. Subsidiaries are observations that have parents that list their stocks. Wholly-owned subsidiaries are subsidiaries whose stakes are completely held by their parents. Business groups consist of parents and their subsidiaries. CTS parents are parents that have adopted the CTS. CTS effective parents are parents that adopt the CTS in any of the years between 2002 and 2012. For example, a parent that adopts the CTS in 2005 becomes a CTS parent in 2005, but the parent becomes a CTS effective parent in 2002, which is the year of the introduction of the CTS. We use the terms CTS subsidiary, CTS effective subsidiary, CTS wholly-owned subsidiary, CTS effective wholly-owned subsidiary, CTS business group, and CTS effective business group in the same way.

	Total	After 2002
Parent (Business group)	12356	8301
CTS parent (business group)	701	
CTS effective parent (business group)	1395	
Subsidiary	40383	27625
Wholly-owned subsidiary	25769	18398
CTS subsidiary	7119	
CTS effective subsidiary	12205	
CTS wholly-owned subsidiary	4649	
CTS effective wholly-owned subsidiary	8199	

Table 2
Summary statistics

This table separately reports the summary statistics among parents, among subsidiaries, and among business groups. The data periods are between 1994 and 2012. R&D expenses-to-assets ratio is R&D expenses divided by lagged assets in percentage, R&D-Capex difference-to-assets ratio is R&D expense minus capital expenditures divided by lagged assets in percentage, R&D physical capital-to-assets ratio is expenses for physical capital investments in R&D divided by lagged assets in percentage, R&D employees-to-employees ratio is the number of employees engaging in R&D divided by the lagged number of total employees in percentage, capital expenditures-to-assets ratio is capital expenditures divided by lagged assets in percentage, CTS adoption dummy is a dummy variable that takes one when the firms or the firms' parents adopt the CTS, CTS effective adoption dummy is a dummy variable that takes one in 2002 and afterwards if the firms or the firms' parents adopt the CTS in any of the years between 2002 and 2012, market to book ratio is market value of stock plus total liabilities divided by lagged assets, cash flow is after-tax profits plus depreciation expenses plus R&D expenses divided by lagged assets in percentage, and asset value is the book value of total assets. We use the parent's market to book ratio when the unit of analysis is subsidiaries or business groups.

	Parent			Subsidiary			Business group		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
R&D expenses-to-assets ratio	2.09	2.29	12356	0.97	2.33	40383	2.00	2.22	12356
R&D-Capex difference-to-assets ratio	-1.52	4.07	12193	-3.78	7.37	37469	-1.75	4.16	12193
R&D physical capital-to-assets ratio	0.20	0.35	8467	0.06	0.23	26537	0.19	0.33	8467
R&D employees-to-employees ratio	8.50	10.72	11960	3.27	7.59	38398	7.24	8.71	11960
Capital expenditures-to-assets ratio	3.61	3.60	12193	4.81	7.16	37469	3.75	3.82	12193
CTS adoption dummy (after 2002)	0.08	0.28	8301	0.26	0.44	27625	0.08	0.28	8301
CTS effective adoption dummy (after 2002)	0.17	0.37	8301	0.44	0.50	27625	0.17	0.37	8301
Market to book ratio	1.15	0.52	12356	1.31	0.50	40383	1.15	0.52	12356
Cash flow	6.32	5.28	12356	6.72	8.01	40383	6.37	5.38	12356
Asset value (billion yen)	289	822	12356	15	45	40383	344	1002	12356

Table 3

The riskiness of R&D

This table presents the estimation results to examine whether R&D is associated with future earnings volatility. The data periods are between 1994 and 2012. The unit of analysis is business groups. We use OLS for estimation. The regressand is earnings volatility that is the standard deviation of after-tax ROA across the future five years. The regressors are either R&D expenses-to-assets ratio that is R&D expenses divided by lagged assets in percentage, R&D-Capex difference-to-assets ratio that is R&D expense minus capital expenditures divided by lagged assets in percentage, R&D physical capital-to-assets ratio that is expenses for physical capital investments in R&D divided by lagged assets in percentage, R&D employees-to-employees ratio that is the number of employees engaging in R&D divided by the lagged number of total employees in percentage, or capital expenditures-to-assets ratio that is capital expenditures divided by lagged assets in percentage. All the columns include Ln(assets) that is natural log of assets and leverage that is total liabilities divided by lagged assets in percentage as regressors. We include industry-year dummy in all columns. Standard errors reported in parentheses are clustered at the industry-year-level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Volatility of future five-year after tax profit				
	(1)	(2)	(3)	(4)	(5)
R&D expenses-to-assets ratio	0.109***				
	(0.025)				
R&D-Capex difference-to-assets ratio		0.036***			
		(0.010)			
R&D physical capital-to-assets ratio			0.240**		
			(0.118)		
R&D employees-to-employees ratio				0.018***	
				(0.006)	
Capital expenditures-to-assets ratio					-0.019*
					(0.011)
Ln(assets)	-0.222***	-0.193***	-0.137***	-0.183***	-0.187***
	(0.029)	(0.028)	(0.031)	(0.029)	(0.028)
Leverage	0.007***	0.007***	0.009***	0.008***	0.007***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Industry-year dummy	Yes	Yes	Yes	Yes	Yes
Observations	7464	7423	5796	7241	7423

Table 4

The instruments and CTS adoption

This table presents the estimation results to examine whether the instruments can explain the business groups' decision to adopt the CTS. We use the data in 2002. The unit of analysis is business groups. We use the Probit model for estimation. The regressand is the CTS effective adoption dummy that is a dummy variable that takes one if the business groups adopt the CTS in any of the years between 2002 and 2012. The regressors are PPSN dummy that is a dummy variable that takes one if the parents have positive income and one of their wholly-owned subsidiaries has past losses, PNSP dummy that is a dummy variable that takes one if the parents have past losses and one of their wholly-owned subsidiaries has positive income, SNSP dummy that is a dummy variable that takes one if one of the business group's wholly-owned subsidiaries has positive income and one of the business group's wholly-owned subsidiaries has past losses, and PN dummy that is a dummy variable that takes one if the parents have past losses. We classify that the firms have positive income when these firms' accumulated after-tax profits across the previous five years are positive. We use information of tax loss carryforwards for the parents' past losses. We use after-tax profits aggregated across the previous five years to calculate the subsidiaries' past losses. These four dummy variables used as regressors are evaluated in 2001. We use robust standard errors that are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	CTS effective adoption dummy				
	(1)	(2)	(3)	(4)	(5)
PPSN dummy	0.586***				0.130
	(0.125)				(0.170)
PNSP dummy		0.752***			0.192
		(0.111)			(0.170)
SPSN dummy			0.867***		0.632***
			(0.116)		(0.189)
PN dummy				0.653***	0.467***
				(0.131)	(0.154)
Observations	762	762	762	762	762

Table 5
Falsification test: Exclusion restriction

This table presents the estimation results to examine whether the instruments do not violate the exclusion restriction. The data periods are between 1994 and 2001. The unit of analysis is business groups. We use the one-step system GMM for estimation. The regressand is either R&D expenses-to-assets ratio that is R&D expenses divided by lagged assets in percentage or R&D-Capex difference-to-assets ratio that is R&D expense minus capital expenditures divided by lagged assets in percentage. The regressors are PPSN dummy that is a dummy variable that takes one if the parents have positive income and one of their wholly-owned subsidiaries has past losses, PNSP dummy that is a dummy variable that takes one if the parents have past losses and one of their wholly-owned subsidiaries has positive income, SNSP dummy that is a dummy variable that takes one if one of the business group's wholly-owned subsidiaries has positive income and one of the business group's wholly-owned subsidiaries has past losses, and PN dummy that is a dummy variable that takes one if the parents have past losses. We use one-year lagged variables for these four dummy variables in regression. We use after-tax profits aggregated across the previous five years to calculate the positive income and the past losses. We include one year lagged dependent variables. We also include market to book ratio that is market value of stock plus total liabilities divided by lagged assets and cash flow that is after-tax profits plus depreciation expenses plus R&D expenses divided by lagged assets in percentage as regressors. We include firm-fixed effects and year dummy in all columns. GMM lag 3 to 4 refers to the models where we use lagged level dated t-3 and t-4 for the differenced equation and the lagged differences dated t-2 for the level equation as the GMM instruments. GMM lag 4 to 5 can be interpreted in a similar way. Joint significance p-value is the p-value of the test for the joint significance of the four instruments. Hansen p-value is the p-value of the Hansen test for overidentifying restrictions. AR 1 p-value, AR 2 p-value, and AR 3 p-value respectively report the p-value from the test of no first-order, second-order, or third-order autocorrelation on the differenced residuals. Standard errors reported in parentheses are clustered at the firm-level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	R&D expenses-to-assets ratio		R&D-Capex difference-to-assets ratio	
	(1)	(2)	(3)	(4)
Lagged PPSN dummy	-0.008	0.035	-0.300	-0.104
	(0.067)	(0.071)	(0.278)	(0.285)
Lagged PNSP dummy	0.058	0.011	0.556**	0.399
	(0.064)	(0.051)	(0.278)	(0.261)
Lagged SPSN dummy	0.120	-0.004	0.360	0.141
	(0.088)	(0.074)	(0.267)	(0.281)
Lagged PN dummy	-0.067	0.137	0.047	0.168
	(0.121)	(0.139)	(0.421)	(0.624)
Lagged dependent variable	0.768***	0.910***	0.416***	0.669***
	(0.078)	(0.057)	(0.098)	(0.155)
Market to book ratio	0.013	-0.076	0.072	-0.758
	(0.149)	(0.185)	(0.339)	(0.711)
Cash flow	0.037	0.057	0.010	0.105
	(0.039)	(0.036)	(0.090)	(0.162)
Firm-fixed effect	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes
GMM lag	3 to 4	4 to 5	3 to 4	4 to 5
Observations	4055	4055	4054	4054
Joint significance p-value	0.473	0.211	0.175	0.317
Hansen p-value	0.565	0.404	0.003	0.030
AR 1 p-value	0.000	0.001	0.000	0.000
AR 2 p-value	0.241	0.227	0.059	0.018
AR 3 p-value	0.930	0.993	0.606	0.445

Table 6

The CTS and R&D

This table presents the estimation results to examine whether the CTS increases R&D expenses. The data periods are between 1994 and 2012. We report the estimation results when the units of analysis are parents, subsidiaries, and business groups respectively in Panels A, B, and C. We use the one-step system GMM for estimation. The regressand is R&D expenses-to-assets ratio that is R&D expenses divided by lagged assets in percentage. The main regressor is either the CTS adoption dummy that is a dummy variable that takes one when the firms or the firms' parents adopt the CTS or the CTS effective adoption dummy that is a dummy variable that takes one in 2002 and afterwards if the firms or the firms' parents adopt the CTS in any of the years between 2002 and 2012. We instrument the CTS dummies with the following four instruments in some empirical specifications: PPSN dummy that is a dummy variable that takes one if the parents have positive income and one of their wholly-owned subsidiaries has past losses; PNSP dummy that is a dummy variable that takes one if the parents have past losses and one of their wholly-owned subsidiaries has positive income; SNSP dummy that is a dummy variable that takes one if one of the business group's wholly-owned subsidiaries has positive income and one of the business group's wholly-owned subsidiaries has past losses; and PN dummy that is a dummy variable that takes one if the parents have past losses. We classify that the firms have positive income when these firms' accumulated after-tax profits across the previous five years are positive. We use information of tax loss carryforwards for the parents' past losses. We use after-tax profits aggregated across the previous five years to calculate the subsidiaries' past losses. The instruments take zero up to 2001, and they take the value evaluated in the year of 2001 in 2002 and afterwards. We include one year lagged dependent variables. We also include market to book ratio that is market value of stock plus total liabilities divided by lagged assets and cash flow that is after-tax profits plus depreciation expenses plus R&D expenses divided by lagged assets in percentage as regressors. We use the parent's market to book ratio when the unit of analysis is subsidiaries or business groups. When the unit of analysis is subsidiaries, we include wholly-owned dummy that is a dummy variable that takes one if the subsidiaries stocks are completely held by their parents, and we include the interaction of the CTS dummies with the wholly-owned dummy. We include firm-fixed effects and year dummy in all columns. GMM lag 3 to 4 refers to the models where we use lagged level dated t-3 and t-4 for the differenced equation and the lagged differences dated t-2 for the level equation as the GMM instruments. GMM lag 4 to 5 can be interpreted in a similar way. Hansen p-value is the p-value of the Hansen test for overidentifying restrictions. Diff-in-Hansen p-value is the p-value of the difference-in-Hansen test to examine the validity of the four instruments. AR 1 p-value, AR 2 p-value, and AR 3 p-value respectively report the p-value from the test of no first-order, second-order, or third-order autocorrelation on the differenced residuals. Standard errors reported in parentheses are clustered at the firm-level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Continued-Table 6

	Panel A: Parent							
	R&D expenses-to-assets ratio							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CTS adoption dummy	0.103***	0.669***	0.083**	0.590***				
	(0.040)	(0.208)	(0.041)	(0.196)				
CTS effective adoption dummy					0.162***	0.627***	0.142***	0.507***
					(0.037)	(0.133)	(0.041)	(0.141)
Lagged R&D expenses-to-assets ratio	0.894***	0.893***	0.893***	0.892***	0.882***	0.860***	0.884***	0.868***
	(0.022)	(0.024)	(0.025)	(0.026)	(0.023)	(0.024)	(0.026)	(0.029)
Market to book ratio	0.051	0.056	0.210***	0.198***	0.044	0.033	0.202***	0.166***
	(0.063)	(0.057)	(0.069)	(0.064)	(0.063)	(0.057)	(0.069)	(0.064)
Cash flow	0.034***	0.030***	0.022*	0.022**	0.037***	0.038***	0.024**	0.030***
	(0.012)	(0.010)	(0.012)	(0.010)	(0.012)	(0.010)	(0.012)	(0.011)
Firm-fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
GMM lag	3 to 4	3 to 4	4 to 5	4 to 5	3 to 4	3 to 4	4 to 5	4 to 5
CTS dummy instrumented?	No	Yes	No	Yes	No	Yes	No	Yes
Observations	12356	12356	12356	12356	12356	12356	12356	12356
Hansen p-value	0.011	0.042	0.209	0.303	0.009	0.027	0.188	0.237
Diff-in-Hansen p-value		0.848		0.433		0.414		0.801
AR 1 p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR 2 p-value	0.066	0.068	0.038	0.042	0.074	0.094	0.042	0.056
AR 3 p-value	0.658	0.668	0.766	0.754	0.639	0.610	0.747	0.691

Continued-Table 6

	Panel B: Subsidiary							
	R&D expenses-to-assets ratio							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CTS adoption dummy×Wholly-owned dummy	-0.058	0.021	-0.049	0.018				
	(0.038)	(0.074)	(0.031)	(0.065)				
CTS adoption dummy	0.112***	0.255***	0.086***	0.176***				
	(0.037)	(0.076)	(0.030)	(0.066)				
CTS effective adoption dummy×Wholly-owned dummy					-0.063**	0.003	-0.046*	0.013
					(0.032)	(0.049)	(0.026)	(0.042)
CTS effective adoption dummy					0.104***	0.236***	0.074***	0.172***
					(0.032)	(0.063)	(0.026)	(0.055)
Lagged R&D expenses-to-assets ratio	0.777***	0.786***	0.836***	0.842***	0.776***	0.782***	0.835***	0.836***
	(0.035)	(0.033)	(0.034)	(0.033)	(0.035)	(0.034)	(0.034)	(0.033)
Wholly-owned dummy	-0.047***	-0.055***	-0.031**	-0.039**	-0.041***	-0.059***	-0.027**	-0.045***
	(0.015)	(0.018)	(0.013)	(0.016)	(0.015)	(0.019)	(0.013)	(0.017)
Market to book ratio	0.011	0.010	0.011	0.004	0.006	-0.013	0.007	-0.019
	(0.034)	(0.032)	(0.037)	(0.034)	(0.034)	(0.032)	(0.037)	(0.035)
Cash flow	0.044***	0.040***	0.026**	0.025***	0.045***	0.042***	0.026**	0.027***
	(0.010)	(0.008)	(0.011)	(0.009)	(0.010)	(0.009)	(0.011)	(0.009)
Firm-fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
GMM lag	3 to 4	3 to 4	4 to 5	4 to 5	3 to 4	3 to 4	4 to 5	4 to 5
CTS dummy instrumented?	No	Yes	No	Yes	No	Yes	No	Yes
Observations	40383	40383	40383	40383	40383	40383	40383	40383
Hansen p-value	0.150	0.202	0.081	0.118	0.159	0.226	0.088	0.145
Diff-in-Hansen p-value		0.997		0.947		0.992		0.961
AR 1 p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR 2 p-value	0.085	0.075	0.040	0.039	0.087	0.081	0.040	0.042
AR 3 p-value	0.701	0.708	0.734	0.731	0.694	0.690	0.728	0.716

Continued-Table 6

	Panel C: Business group							
	R&D expenses-to-assets ratio							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CTS adoption dummy	0.150**	0.611**	0.076**	0.429***				
	(0.059)	(0.253)	(0.033)	(0.159)				
CTS effective adoption dummy					0.212***	0.675***	0.125***	0.452***
					(0.064)	(0.169)	(0.038)	(0.133)
Lagged R&D expenses-to-assets ratio	0.838***	0.849***	0.904***	0.904***	0.826***	0.808***	0.894***	0.876***
	(0.052)	(0.049)	(0.027)	(0.025)	(0.053)	(0.052)	(0.029)	(0.032)
Market to book ratio	-0.091	-0.047	0.093	0.095	-0.096	-0.075	0.086	0.064
	(0.103)	(0.084)	(0.082)	(0.071)	(0.103)	(0.087)	(0.082)	(0.071)
Cash flow	0.075**	0.061**	0.032**	0.029***	0.077**	0.070***	0.034**	0.037***
	(0.032)	(0.025)	(0.014)	(0.010)	(0.032)	(0.026)	(0.014)	(0.011)
Firm-fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
GMM lag	3 to 4	3 to 4	4 to 5	4 to 5	3 to 4	3 to 4	4 to 5	4 to 5
CTS dummy instrumented?	No	Yes	No	Yes	No	Yes	No	Yes
Observations	12356	12356	12356	12356	12356	12356	12356	12356
Hansen p-value	0.113	0.118	0.300	0.376	0.100	0.194	0.302	0.420
Diff-in-Hansen p-value		0.901		0.720		0.284		0.704
AR 1 p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR 2 p-value	0.049	0.044	0.019	0.020	0.053	0.054	0.020	0.022
AR 3 p-value	0.717	0.692	0.584	0.592	0.727	0.723	0.590	0.612

Table 7

The CTS and R&D-Capex difference or the CTS and capital expenditures

This table presents the estimation results to examine whether the CTS increases R&D-Capex difference or capital expenditures. The units of analysis are either parents, subsidiaries, or business groups. The regressand is either R&D-Capex difference-to-assets ratio that is R&D expense minus capital expenditures divided by lagged assets in percentage or capital expenditures-to-assets ratio that is capital expenditures divided by lagged assets in percentage. See Table 6 for the estimation procedures as well as variable definitions.

	Parent	Subsidiary	Business group	Parent	Subsidiary	Business group
	R&D-Capex difference-to-assets ratio			Capital expenditures-to-assets ratio		
	(1)	(2)	(3)	(4)	(5)	(6)
CTS effective adoption dummy	1.854***	0.627**	1.674***	-0.242	-0.233	-0.116
	(0.454)	(0.281)	(0.470)	(0.311)	(0.262)	(0.352)
CTS effective adoption dummy×Wholly-owned dummy		0.318			-0.403*	
		(0.237)			(0.224)	
Lagged dependent variable	0.560***	0.567***	0.532***	0.498***	0.519***	0.450***
	(0.043)	(0.038)	(0.054)	(0.046)	(0.040)	(0.056)
Market to book ratio	0.148	-0.081	-0.032	-0.059	0.110	0.112
	(0.213)	(0.203)	(0.243)	(0.197)	(0.204)	(0.238)
Cash flow	0.014	-0.102***	0.041	0.099***	0.194***	0.081**
	(0.033)	(0.037)	(0.040)	(0.031)	(0.038)	(0.037)
Wholly-owned dummy		-0.317***			0.239**	
		(0.104)			(0.097)	
Firm-fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
GMM lag	3 to 4	3 to 4	3 to 4	3 to 4	3 to 4	3 to 4
CTS dummy instrumented?	Yes	Yes	Yes	Yes	Yes	Yes
Observations	12193	37469	12193	12193	37469	12193
Hansen p-value	0.000	0.000	0.001	0.000	0.000	0.000
Diff-in-Hansen p-value	0.167	0.103	0.062	0.026	0.107	0.014
AR 1 p-value	0.000	0.000	0.000	0.000	0.000	0.000
AR 2 p-value	0.000	0.000	0.000	0.000	0.000	0.000
AR 3 p-value	0.589	0.176	0.741	0.547	0.194	0.593

Table 8

The CTS and R&D physical capital or the CTS and R&D human capital

This table presents the estimation results to examine whether the CTS increases R&D physical capital or R&D human capital. The units of analysis are either parents, subsidiaries, or business groups. The regressand is either R&D physical capital-to-assets ratio that is expenses for physical capital investments in R&D divided by lagged assets in percentage or R&D employees-to-employees ratio that is the number of employees engaging in R&D divided by the lagged number of total employees in percentage. See Table 6 for the estimation procedures as well as variable definitions.

	Parent	Subsidiary	Business group	Parent	Subsidiary	Business group
	R&D physical capital-to-assets ratio			R&D employees-to-employees ratio		
	(1)	(2)	(3)	(4)	(5)	(6)
CTS effective adoption dummy	0.083**	0.015*	0.073**	1.138**	0.144	0.614*
	(0.036)	(0.009)	(0.035)	(0.559)	(0.124)	(0.364)
CTS effective adoption dummy×Wholly-owned dummy		0.004			0.089	
		(0.007)			(0.104)	
Lagged dependent variable	0.481***	0.720***	0.471***	0.905***	0.926***	0.907***
	(0.050)	(0.053)	(0.053)	(0.034)	(0.025)	(0.027)
Market to book ratio	0.044**	-0.007	0.049**	0.664**	0.156*	0.254
	(0.022)	(0.007)	(0.023)	(0.336)	(0.086)	(0.247)
Cash flow	0.016***	0.007***	0.015***	0.087	0.041**	0.086*
	(0.004)	(0.002)	(0.004)	(0.053)	(0.021)	(0.047)
Wholly-owned dummy		-0.009***			-0.110**	
		(0.003)			(0.051)	
Firm-fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
GMM lag	3 to 4	3 to 4	3 to 4	3 to 4	3 to 4	3 to 4
CTS dummy instrumented?	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8467	26537	8467	11960	38398	11960
Hansen p-value	0.053	0.563	0.070	0.803	0.413	0.773
Diff-in-Hansen p-value	0.498	0.263	0.524	0.920	0.872	0.986
AR 1 p-value	0.000	0.000	0.000	0.000	0.000	0.000
AR 2 p-value	0.195	0.000	0.136	0.019	0.086	0.059
AR 3 p-value	0.464	0.462	0.771	0.708	0.243	0.471

Table 9

The CTS and risk-sharing among business group members

This table presents the estimation results to examine whether the CTS encourages risk-sharing among business group members. The data periods are between 1994 and 2012. The unit of analysis is business groups. We use the one-step system GMM for estimation. We respectively report the estimation results when the regressand is the differences in the following five variables between the parents and their subsidiaries: R&D expenses-to-assets ratio that is R&D expenses divided by lagged assets in percentage, R&D-Capex difference-to-assets ratio that is R&D expense minus capital expenditures divided by lagged assets in percentage, capital expenditures-to-assets ratio that is capital expenditures divided by lagged assets in percentage, R&D physical capital-to-assets ratio that is expenses for physical capital investments in R&D divided by lagged assets in percentage, and R&D employees-to-employees ratio that is the number of employees engaging in R&D divided by the lagged number of total employees in percentage. When we calculate the difference in R&D expenses-to-assets ratio between the parents and their subsidiaries, we first aggregate necessary variables across all the subsidiaries. We then subtract the subsidiaries' R&D expenses-to-assets ratio from the parent's R&D expenses-to-assets ratio. Other regressands are calculated in the same way. The main regressor is the CTS effective adoption dummy that is a dummy variable that takes one in 2002 and afterwards if the business groups adopt the CTS in any of the years between 2002 and 2012. We instrument the CTS dummies with the following four instruments: PPSN dummy that is a dummy variable that takes one if the parents have positive income and one of their wholly-owned subsidiaries has past losses; PNSP dummy that is a dummy variable that takes one if the parents have past losses and one of their wholly-owned subsidiaries has positive income; SNSP dummy that is a dummy variable that takes one if one of the business group's wholly-owned subsidiaries has positive income and one of the business group's wholly-owned subsidiaries has past losses; and PN dummy that is a dummy variable that takes one if the parents have past losses. We classify that the firms have positive income when these firms' accumulated after-tax profits across the previous five years are positive. We use information of tax loss carryforwards for the parents' past losses. We use after-tax profits aggregated across the previous five years to calculate the subsidiaries' past losses. The instruments take zero up to 2001, and they take the value evaluated in the year of 2001 in 2002 and afterwards. We include one year lagged dependent variables. We also include market to book ratio that is market value of stock plus total liabilities divided by lagged assets and cash flow that is after-tax profits plus depreciation expenses plus R&D expenses divided by lagged assets in percentage as regressors. We include firm-fixed effects and year dummy in all columns. GMM lag 3 to 4 refers to the models where we use lagged level dated t-3 and t-4 for the differenced equation and the lagged differences dated t-2 for the level equation as the GMM instruments. Hansen p-value is the p-value of the Hansen test for overidentifying restrictions. Diff-in-Hansen p-value is the p-value of the difference-in-Hansen test to examine the validity of the four instruments. AR 1 p-value, AR 2 p-value, and AR 3 p-value respectively report the p-value from the test of no first-order, second-order, or third-order autocorrelation on the differenced residuals. Standard errors reported in parentheses are clustered at the firm-level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Continued-Table 9

	Difference in R&D expenses-to-assets ratio	Difference in R&D-Capex difference-to-assets	Difference in Capital expenditures-to-assets ratio	Difference in R&D physical capital-to-assets ratio	Difference in R&D employees-to-employees ratio
	(1)	(2)	(3)	(4)	(5)
CTS effective adoption dummy	0.288**	0.456	-1.174**	0.060*	1.393***
	(0.115)	(0.513)	(0.511)	(0.036)	(0.533)
Lagged dependent variable	0.837***	0.360***	0.337***	0.516***	0.885***
	(0.025)	(0.055)	(0.049)	(0.064)	(0.028)
Market to book ratio	0.049	0.524*	0.452	0.042*	0.478
	(0.072)	(0.297)	(0.296)	(0.025)	(0.366)
Cash flow	0.025**	0.097**	0.066	0.014***	0.085*
	(0.011)	(0.042)	(0.041)	(0.004)	(0.047)
Firm-fixed effect	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes
GMM lag	3 to 4	3 to 4	3 to 4	3 to 4	3 to 4
CTS dummy instrumented?	Yes	Yes	Yes	Yes	Yes
Observations	12356	12193	12193	8467	11960
Hansen p-value	0.060	0.495	0.059	0.062	0.228
Diff-in-Hansen p-value	0.589	0.678	0.531	0.397	0.576
AR 1 p-value	0.000	0.000	0.000	0.000	0.000
AR 2 p-value	0.034	0.241	0.108	0.061	0.001
AR 3 p-value	0.519	0.328	0.308	0.917	0.256

Table 10

The CTS and risk-sharing by asset types

This table presents the estimation results to examine whether the CTS encourages risk-sharing by asset types. The data periods are between 1994 and 2012. The unit of analysis is business groups. Column (1) keeps business groups if the average of their R&D employees-to-employees ratio, which is the number of employees engaging in R&D divided by the lagged number of total employees in percentage, calculated using the data in 2002 and afterwards is higher than the average calculated from the data up to 2001. Column (2) keeps observations in the opposite case. Column (3) keeps business groups if the average of their R&D physical capital-to-assets ratio, which is expenses for physical capital investments in R&D divided by lagged assets in percentage, calculated using the data in 2002 and afterwards is higher than the average calculated from the data up to 2001. Column (4) keeps observations in the opposite case. We use the one-step system GMM for estimation. The regressand is either R&D physical capital-to-assets ratio or R&D employees-to-employees ratio. The main regressor is the CTS effective adoption dummy that is a dummy variable that takes one in 2002 and afterwards if the business groups adopt the CTS in any of the years between 2002 and 2012. We instrument the CTS dummies with the following four instruments: PPSN dummy that is a dummy variable that takes one if the parents have positive income and one of their wholly-owned subsidiaries has past losses; PNSP dummy that is a dummy variable that takes one if the parents have past losses and one of their wholly-owned subsidiaries has positive income; SNSP dummy that is a dummy variable that takes one if one of the business group's wholly-owned subsidiaries has positive income and one of the business group's wholly-owned subsidiaries has past losses; and PN dummy that is a dummy variable that takes one if the parents have past losses. We classify that the firms have positive income when these firms' accumulated after-tax profits across the previous five years are positive. We use information of tax loss carryforwards for the parents' past losses. We use after-tax profits aggregated across the previous five years to calculate the subsidiaries' past losses. The instruments take zero up to 2001, and they take the value evaluated in the year of 2001 in 2002 and afterwards. We include one year lagged dependent variables. We also include market to book ratio that is market value of stock plus total liabilities divided by lagged assets and cash flow that is after-tax profits plus depreciation expenses plus R&D expenses divided by lagged assets in percentage as regressors. We include firm-fixed effects and year dummy in all columns. GMM lag 3 to 4 refers to the models where we use lagged level dated t-3 and t-4 for the differenced equation and the lagged differences dated t-2 for the level equation as the GMM instruments. Hansen p-value is the p-value of the Hansen test for overidentifying restrictions. Diff-in-Hansen p-value is the p-value of the difference-in-Hansen test to examine the validity of the four instruments. AR 1 p-value, AR 2 p-value, and AR 3 p-value respectively report the p-value from the test of no first-order, second-order, or third-order autocorrelation on the differenced residuals. Standard errors reported in parentheses are clustered at the firm-level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Continued-Table 10

	Increased R&D employees-to-employees ratio	Not Increased R&D employees-to-employees ratio	Increased R&D physical capital investments-to-assets ratio	Not Increased R&D physical capital investments-to-assets ratio
	R&D physical capital investments-to-assets ratio		R&D employees-to-employees ratio	
	(1)	(2)	(3)	(4)
CTS effective adoption dummy	-0.033	0.141***	-0.286	1.223***
	(0.046)	(0.043)	(0.522)	(0.471)
Lagged dependent variable	0.458***	0.501***	0.915***	0.889***
	(0.073)	(0.051)	(0.039)	(0.027)
Market to book ratio	0.091***	-0.032	0.441	0.005
	(0.028)	(0.029)	(0.443)	(0.269)
Cash flow	0.011**	0.018***	0.021	0.144***
	(0.006)	(0.004)	(0.065)	(0.048)
Firm-fixed effect	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes
GMM lag	3 to 4	3 to 4	3 to 4	3 to 4
CTS dummy instrumented?	Yes	Yes	Yes	Yes
Observations	4388	3751	3960	7452
Hansen p-value	0.163	0.298	0.306	0.618
Diff-in-Hansen p-value	0.549	0.737	0.397	0.900
AR 1 p-value	0.000	0.000	0.000	0.000
AR 2 p-value	0.648	0.124	0.084	0.414
AR 3 p-value	0.047	0.136	0.239	0.557

Table 11
Restricting year periods

This table presents the estimation results to examine whether we can find similar estimates when we exclude some year periods from our main regression. The unit of analysis is business groups. The regressand is R&D expenses-to-assets ratio that is R&D expenses divided by lagged assets in percentage. The main regressor is the CTS adoption dummy that is a dummy variable that takes one when the business groups adopt the CTS or the CTS effective adoption dummy that is a dummy variable that takes one in 2002 and afterwards if the business groups adopt the CTS in any of the years between 2002 and 2012. Entire sample refers to our estimation results from Table 6. Excluding one year in the second row means that we exclude year of CTS adoption of the business groups when the regressor is the CTS adoption dummy, and it means that we exclude year of 2002 when the regressor is the CTS effective adoption dummy. Excluding two years in the third row means that we exclude year of CTS adoption as well as one year before adopting the CTS when the regressor is the CTS adoption dummy, and it means that we exclude years of 2002 and 2003 when the regressor is the CTS effective adoption dummy. Although we report only coefficient estimates of the CTS dummies, we include other variables in regression. See Table 6 for the details of the estimation procedures. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Regressor: CTS adoption dummy		Regressor: CTS effective adoption dummy	
	R&D expenses-to-assets ratio			
	(1)	(2)	(3)	(4)
Entire sample	0.611**	0.429***	0.675***	0.452***
	(0.253)	(0.159)	(0.169)	(0.133)
Excluding one year	0.615***	0.552***	0.808***	0.543***
	(0.193)	(0.170)	(0.203)	(0.156)
Excluding two years	0.643***	0.692***	0.837***	0.584***
	(0.213)	(0.220)	(0.211)	(0.168)

Table 12
Another year to evaluate the instruments

This table presents the estimation results to examine whether we can find similar estimates when we change the year to evaluate the instruments. The unit of analysis is business groups. The regressand is R&D expenses-to-assets ratio that is R&D expenses divided by lagged assets in percentage. The main regressor is the CTS adoption dummy that is a dummy variable that takes one when the business groups adopt the CTS or the CTS effective adoption dummy that is a dummy variable that takes one in 2002 and afterwards if the business groups adopt the CTS in any of the years between 2002 and 2012. Instruments evaluated in 2001 refers to the original model from Table 6. The second row and the third row respectively change the year to evaluate the instruments in 2000 and 1999. Although we report only coefficient estimates of the CTS dummies, we include other variables in regression. See Table 6 for the details of the estimation procedures. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Regressor: CTS adoption dummy		Regressor: CTS effective adoption dummy	
	R&D expenses-to-assets ratio			
	(1)	(2)	(3)	(4)
Instruments evaluated in 2001	0.611**	0.429***	0.675***	0.452***
	(0.253)	(0.159)	(0.169)	(0.133)
Instruments evaluated in 2000	0.327*	0.289**	0.387***	0.302***
	(0.177)	(0.133)	(0.104)	(0.097)
Instruments evaluated in 1999	0.360**	0.354**	0.356***	0.310***
	(0.178)	(0.142)	(0.097)	(0.098)

Table 13

The CTS and R&D tax credit

This table presents the estimation results to examine the relationship between the CTS and R&D tax credit. We include interaction terms of CTS dummies with 20% credit limit year dummy that takes one in 2006 and 2007, 30% credit limit year dummy that takes one in 2008 and 2012, and 40% credit limit year dummy that takes one in 2009, 2010, and 2011. We instrument each of the interaction terms by the interaction of the four instruments with the relevant year period dummies. See Table 6 for the estimation procedures as well as variable definitions.

	R&D expenses-to-assets ratio	
	(1)	(2)
CTS effective adoption dummy	0.584***	0.395***
	(0.163)	(0.138)
CTS effective adoption dummy× 20% credit limit years	0.227	0.165
	(0.254)	(0.269)
CTS effective adoption dummy× 30% credit limit years	0.455*	0.241
	(0.242)	(0.203)
CTS effective adoption dummy× 40% credit limit years	-0.013	-0.008
	(0.168)	(0.168)
Lagged R&D expenses-to-assets ratio	0.803***	0.873***
	(0.055)	(0.032)
Market to book ratio	-0.071	0.075
	(0.087)	(0.071)
Cash flow	0.071***	0.036***
	(0.027)	(0.011)
Firm-fixed effect	Yes	Yes
Year dummy	Yes	Yes
GMM lag	3 to 4	4 to 5
CTS dummy instrumented?	Yes	Yes
Observations	12356	12356
Hansen p-value	0.268	0.439
Diff-in-Hansen p-value	0.556	0.551
AR 1 p-value	0.000	0.000
AR 2 p-value	0.057	0.022
AR 3 p-value	0.698	0.613

CHAPTER 2: Stock market listing and corporate tax aggressiveness: Evidence from legal reforms in squeeze out in Japan

1. Introduction

All firms appear to have an incentive to be tax aggressive to reduce tax liabilities.[57] However, empirical studies provide evidence that there exists a considerable variation in individual firms' tax aggressiveness.[58] This observation raises a question on what tradeoff firms face when they choose their optimal level of tax aggressiveness. A clear cost of tax avoidance for firms is resources spent to establish tax avoidance schemes. Another cost is potential tax penalties imposed on firms. The literature points out that these costs are smaller than the benefits from tax sheltering in the U.S. (Desai and Dharmapala (2009a)). This argument is likely to be applied in Japan as well where the corporate tax rates are around 40% after 1990s, which are relatively high compared to other countries. More important, these costs do not explain the existing variation of tax aggressiveness given that all firms in the same countries are subject to the same tax systems.

Recent literature since Crocker and Slemrod (2005) and Desai and Dharmapala (2006) links corporate tax aggressiveness with agency costs. They emphasize that managers, who are not necessarily owners of the firms, choose the level of tax aggressiveness. Since tax sheltering is obscured from the tax authority by its nature, it is obscured from outside investors as well. Investors can be skeptical whether the tax sheltering aims to enhance shareholder value or it is motivated by managers' self-interests. If investors believe that the latter factor outweighs the former factor, tax sheltering reduces firm value among publicly-traded (listed) companies through a drop in stock prices. Public companies' managers, predicting the negative responses from stock markets, choose to be less tax aggressive. In contrast, this tradeoff does not affect privately-held (unlisted) companies' managerial incentives because their stocks are not traded in public markets.

This argument does not conclude that a negative association between stock market listing and tax aggressiveness is causal. This is because the ownership of private companies is more highly concentrated than that of public companies on average. To eliminate this potential ownership effect, our main analysis uses a variation in stock listing among firms whose ownership is concentrated.

[57] We use "tax aggressiveness", "tax sheltering", "tax evasion" and "tax avoidance" interchangeably in this paper.
[58] The literature in tax aggressiveness is surveyed in Slemrod and Yitzhaki (2002) and Hanlon and Heitzman (2010) among others.

Specifically, we compare tax aggressiveness between public subsidiaries and private subsidiaries. Subsidiaries refer to companies whose majority of shares are held by their parent companies.

There remains a concern that OLS estimates are biased because the choice whether to list stocks is endogenous. We use a “sea change” in corporate law (Milhaupt (2006)) around 2000 as a quasi-natural experiment. These reforms provide parent companies legal rights to forcibly eliminate (or squeeze out) their subsidiaries’ minority shareholders. As a result of these legal reforms, a considerable number of partly owned subsidiaries’ minority shareholders were squeezed out, and these subsidiaries were changed into wholly owned subsidiaries. Firms must delist stocks when they become wholly owned. This is the variation in stock listing we use for identification.

The exogeneity of this variation is questionable, however, since not all subsidiaries have become a target of squeeze out. We instrument the parents’ decision to implement squeeze out transactions. The corporate law requires parents to hold 2/3 of their subsidiaries’ stocks to squeeze out the subsidiaries’ minority shareholders. We argue that the costs for squeeze out decrease in the parents’ ownership, and that the costs are constant above 2/3 ownership. Based on this idea, we use past information of the parent’s ownership ratio to construct an instrument. We include the contemporaneous ownership ratio in regression to control for the direct effects of ownership on tax aggressiveness. We also conduct falsification tests to support that the exclusion restriction is not violated, using the data periods before the legal systems were introduced. In brief, we use a difference-in-differences framework with the IV strategy for identification.

We combine three datasets: Financial Statements Statistics by Corporations collected by the Ministry of Finance; Basic Survey of Japanese Business Structure and Activities collected by the Ministry of Economy, Trade, and Industry; Nikkei NEEDS FinancialQUEST collected by Nikkei Inc. The first two datasets cover both public companies and private companies. This feature allows us to use a variation in stock listing. This variation is not available in other widely used financial datasets such as Compustat because they mostly cover only public companies. The final sample consists of 39976 firm-year observations between 1994 and 2012. 17017 observations are private. 3148 observations have either listed their stocks or delisted their stocks during the data periods. Thus, we observe both cross sectional variations and within-firm variations in stock listing.

Estimation results are consistent with our hypothesis. We find evidence that stock market listing reduces tax aggressiveness among subsidiaries. We obtain robust evidence under the quasi-natural experiment with the IV strategy. The F-statistic of the excluded instrument at the first stage regression is over 30. Thus, the instrument is strong. The falsification test shows that the past ownership does not predict current tax aggressiveness before the legal systems were introduced. This evidence provides support that the instrument does not violate the exclusion restriction. The IV estimates are economically significant as well. The estimates show that stock market listing reduces tax aggressiveness by 0.58 – 1.09 standard deviations of the tax aggressiveness measure.

Our findings have implications for tax policy. The vast literature investigating how taxes affect corporate behavior surveyed in Graham (2003) generally assumes that firms treat tax rates as given. We show that individual firms' effective tax rates are endogenously determined by the choices to list stocks. This finding can be interpreted that stock markets monitor tax avoidance. In other words, our results suggest that financial developments help governments collect tax revenues effectively. This is a testable implication in the literature that studies various determinants of corporate tax revenues (Auerbach and Poterba (1987); Auerbach (2007); and Clausing (2007)). Furthermore, our finding sheds new light on the intense policy debate on tax avoidance.[59] Our findings suggest that more attention can be needed on private companies than on public companies because private companies have stronger incentives to be tax aggressive.

The rest of this paper is organized as follows. Section 2 reviews the literature and presents our hypothesis. Sections 3 explains the data and the research design. Section 4 shows our estimation results. Section 5 concludes.

2. Hypothesis and literature

The literature in tax aggressiveness is classified into two groups. One group of research motivated by Allingham and Sandmo (1972) interprets tax sheltering as an attempt to shift income from governments to individuals. These studies treat tax avoidance as one of various activities that increases after-tax profits. Thus, individuals engage in tax avoidance as long as tax costs, which depend on the frequency of tax audits and the magnitude of tax penalties, are lower than tax benefits. A characteristic of this line of literature is that they presume that those who evade taxes are individuals. Crocker and Slemrod (2005) argue that this framework is not suitable to analyze corporate tax avoidance. This is because agency conflicts resulting from the separation of

[59] For example, OECD's webpage "Fighting tax evasion" describes their policy measures against tax evasion <http://www.oecd.org/ctp/fightingtaxevasion.htm>.

ownership and control in corporations are not considered in this framework.

The second group of relatively new literature relates this agency dimension to corporate tax aggressiveness. Tax avoidance inevitably needs to be obscured from the tax authority, which in turn creates information asymmetry between managers and outside investors. Consequently, managers may seek opportunities for rent diversion when they establish tax sheltering schemes. Predicting the possibility of managerial rent seeking, outside investors can discount firm value when the managers are tax aggressive. This argument implies that investors can make a distinction between income from regular business activities and that from tax avoidance, in contrast to the view discussed in the previous paragraph. If agency costs associated with a high level of tax aggressiveness are sufficiently large, shareholders do not prefer tax avoidance.

There is ample support for the hypothesis that tax sheltering reduces market value of firms. Hanlon and Slemrod (2009) present event study evidence that stock prices react negatively to news that firms involve in tax sheltering. Kim, Li, and Zhang (2011) show that tax avoidance increases stock price crash risks. Anecdotal evidence reveals that complicated tax sheltering schemes contribute to managerial rent seeking, which has resulted in high-profile accounting scandals such as those by Enron or Tyco (Desai, 2005). These pieces of evidence suggest that the negative consequence of tax sheltering outweighs the positive aspect of tax sheltering.

Investors' negative responses to tax sheltering provide contrasting incentives to public companies' managers and to private companies' managers. Recent studies, which will be discussed later, provide evidence that public companies' managers pay considerable attention to the potential impacts of their decisions on stock prices. Therefore, public companies' managers have incentives to be less tax aggressive to maintain stock prices. On the other hand, private companies' managers do not face this incentive problem because stocks of private companies are not traded on public markets. Thus, we expect that public companies are less tax aggressive than private companies through this stock market listing effect.

A simple comparison in tax aggressiveness between public companies and private companies does not necessarily identify how the scrutiny from stock markets affects tax aggressiveness. This is because the ownership is more highly concentrated among private companies than among public companies in general. Owners with large stakes have incentives and abilities to monitor managers.[60] Thus, private companies' shareholders may be able to detect managerial rent-seeking masked by tax avoidance more frequently than public companies' shareholders. Such intensive monitoring in private companies makes their managers less tax aggressive. Another possibility is that private companies' shareholders may be in a better position to ensure that their managers engage in tax sheltering for shareholder value than public companies' shareholders. This higher degree of control in private companies can make their managers more tax aggressive. Although it remains inconclusive whether concentrated ownership increases or decreases tax aggressiveness, this argument suggests that ownership can have direct impacts on tax aggressiveness.

Our estimation therefore treats the impacts of stock market listing on tax aggressiveness as a function of ownership structures. Alternatively, we restrict observations to companies whose ownership is concentrated. We use business group structures as a variation in ownership structures.[61] The ownership of subsidiaries is concentrated by definition. Corporate law in Japan allows subsidiaries to list their stocks on stock exchanges.[62] Therefore, we observe a variation in stock market listing among subsidiaries. The goal of this paper is to identify the causal impacts of stock market listing on tax aggressiveness among subsidiaries, in order to show that managers' optimal choice of tax aggressiveness is affected by the observability of stock prices.

The challenge for this paper is endogeneity of firms' decisions to list stocks. Before turning to a discussion on our research design, we review the literature in the rest of this section. Building on the agency view of tax aggressiveness, several papers examine the relationship between various factors that affect agency costs and corporate tax aggressiveness. Chen, Chen, Cheng, and Shevlin (2010) show that family owned firms are less tax aggressive than non-family owned firms. Their argument is that minority shareholders of family firms are concerned that managers engage in tax avoidance not for shareholder value but for their own private benefits. Thus, managers of family

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[60] Desai and Dharmapala (2006) provide evidence that this argument is applied in the context of tax aggressiveness. They show that high-powered incentives reduce tax aggressiveness among companies whose ownership is dispersed. This evidence suggests that incentive contracts and concentrated ownership are complementary for the purpose of monitoring managers.

[61] A business group is a collection of a parent company and its subsidiaries. Subsidiaries refer to companies whose majority of shares are held by the parent company. The business group is a common corporate structure in Japan. For example, Toyota Motor Corporation is the parent company of Toyota Group that consists of Toyota Motor Corporation and its over 500 subsidiaries. Business group structures have been used in some papers that take advantages of Japanese economic environments for identification (for example, Hoshi, Kashyap, and Scharfstein (1991)).

[62] For example, both Daihatsu Motor and Hino Motors are subsidiaries of Toyota Motor. They are listed on Tokyo Stock Exchange.

firms forgo tax benefits to prevent a drop in stock prices. Chyz, Leung, Li, and Rui (2013) show that labor unionization decreases tax aggressiveness. The authors attribute this result to unions' ability in monitoring managers and to unions' aversion to risks.

A caveat of these two papers is that they use data that mostly cover public companies. The reason is that these papers, or more broadly many papers in corporate finance, use Compustat North America that are collected by Standard and Poor's as a data source. They exploit publicly available financial statements to compile Compustat data files. As a result, most firms covered in Compustat are publicly-traded (listed) companies.[63] This limitation in data availability implies that most studies cannot address agency costs created by the observability of stock prices.[64] We need to have access to confidential data such as those collected by governments or accounting firms to study the impacts of stock market listing on corporate behavior or on financial policy.

Hanlon, Mills, and Slemrod (2007) are an exception that makes a comparison in tax aggressiveness between public companies and private companies. Their tax aggressiveness measure is the level of proposed tax deficiencies. Using tax return data in the U.S., they show that private companies have higher proposed tax deficiencies than public companies. There are three differences between Hanlon, Mills, and Slemrod (2007) and our paper. First, they use a cross sectional variation, while our paper uses both a cross sectional variation and a within-firm variation. Our paper shows that estimation results from cross sectional regression are not necessarily robust when including firm-fixed effects. Second, Hanlon, Mills, and Slemrod (2007) use a non-experimental framework, while our paper uses a quasi-natural experiment as well. Our research design mitigates endogeneity concerns of stock listing. Third, Hanlon, Mills, and Slemrod (2007) do not consider the possibility that the relationship between stock market listing and tax aggressiveness depends on ownership structures. Our paper provides evidence that the impacts of stock market listing are substantially different between among concentrated companies and among

[63] Compustat covers a limited number of private companies. This is because companies issuing public debts disclose financial statements.

[64] There is a small but growing literature in corporate finance that compares public companies with private companies in various aspects. Asker, Farre-Mensa, and Ljungqvist (2015) show that mangers of public companies in the U.S. are overly sensitive to stock prices when choosing the level of capital expenditures. This over-sensitivity causes underinvestment among public companies compared to private companies' counterparts. Michaely and Roberts (2012) show that public companies in the U.K. pay dividends more smoothly than private companies. The authors argue that the scrutiny of public capital markets explains this difference in dividend policy. Brav (2009) shows that private companies are more highly leveraged than public companies in the U.K. The author argues that this is because issuing private equity is more costly than issuing public equity.

unconcentrated companies.

3. Data and research design

3.1. Data description

The main data source is Financial Statements Statistics by Corporations (FS data). This dataset is collected annually by the Ministry of Finance Japan. It covers unconsolidated financial statements of non-financial corporations in Japan. We use the data between 1994 and 2012. A distinctive feature of the FS data is that the data sources are not publicly available financial statements. The Ministry requests corporations to submit their financial information under Statistics Act.[65] This data collection process ensures that the FS data can cover both public companies and private companies. The FS data do not classify whether individual firms are public or private. We use another data, Nikkei NEEDS FinancialQUEST collected by Nikkei Inc., as a secondary source of information. FinancialQUEST includes all firms that are currently listed and those listed in the past.[66] We match observations in the FS data with those in FinancialQUEST based on the corporate name and accounting data. We classify those matched observations as public, and those unmatched observations as private.[67][68]

65 The Ministry of Finance conducts a population survey for large corporations and a sample survey for small corporations. The target of the population survey is all large corporations whose legal capital, which is one component of net worth, is 500 million yen or higher. The threshold of legal capital is 600 million yen in certain years. The response rate is generally over 90% among large corporations. Thus, the data exhibit unbalanced panel structures.

66 We evaluate whether the firms are public or private at the end of the fiscal year. We assume that fiscal year starts in April and it ends in next calendar year's March, which is common in Japan. For example, we evaluate that the company is public in 2005 if the company's stock is listed at the end of 2006 March.

67 There exist discrepancies in the reported corporate name or financial information between the FS data and FinancialQUEST. We can match 90.9% of the observations that are classified as public companies in our final sample based on the company name, legal capital, and assets almost exactly, where we allow a plus or minus one difference in financial information. The naming of corporations is not always consistent between these two datasets. Thus, we match the remaining public observations in FinancialQUEST with those in the FS data based on legal capital, assets, sales, and ordinary income. We match 2.5% of the final public observations after this matching process. We then match the company identification number of the FS data with that in FinancialQUEST. Although this process helps us connect the unmatched observations in the two datasets, this process causes a problem. For example, suppose that a company in the FS data is matched with a company in FinancialQUEST before 2005. If this company established a holding company in 2006, the company recorded in the FS data can be a subsidiary of this holding company in 2006, and the company recorded in FinancialQUEST can be the holding company itself in 2006. We judge the accuracy of this data matching process by hand. We further match the remaining public observations in FiancialQUEST with observations in the FS data with weaker conditions such as allowing 10% differences in financial information between the two datasets. We also check the accuracy of this procedure by hand. Although this classification is conducted carefully, there might remain concerns in the accuracy regarding the 6.6% (100% - 90.9% - 2.5%) of the observations that are classified as public companies in the sample. We obtain almost identical results when we remove these observations.

68 Note that not all public companies in FinancialQUEST are matched with some observations in the FS data. This is because financial corporations are not included in the FS data while they are included in FinancialQUEST, for example.

The FS data cover information on tax liabilities of individual corporations.[69] Available information on tax liabilities varies across years as follows: only corporate income taxes paid are available between 1994 and 1998; only corporate income tax expenses, which take account of deductible temporary differences, are available between 1999 and 2003; and both corporate income taxes paid and corporate income tax expenses are available after 2004. We use corporate income taxes paid as the measure of tax liabilities except for between 1999 and 2003. During these five years, we use corporate income tax expenses instead. The FS data do not include information on ownership structures of individual firms. We obtain this information from Basic Survey of Japanese Business Structure and Activities (BS data) collected by the Ministry of Economy, Trade, and Industry.[70] The BS data also exhibit unbalanced panel structures like the FS data. The BS data tell information of parent companies' ownership ratio. We define the firms' ownership as being concentrated when their parents' ownership is 50% or higher. We define these firms as subsidiaries. We merge the FS data with the BS data based on accounting information.[71]

We merge these datasets and keep necessary observations as follows. First, we keep observations whose lagged assets are one billion yen or higher. Private companies are smaller than public companies on average, and therefore we keep comparable observations in terms of firm size. Second, we keep observations whose legal capital is over 100 million yen because various tax breaks are available for small corporations, which are firms whose legal capital is 100 million yen or less. Third, we keep observations whose before-tax profits are recorded for the past five consecutive years to approximate past accumulated losses.[72] We keep observations both of whose

[69] The Japanese tax system introduced a consolidated taxation system in 2002. This system provides business groups an option to file a consolidated tax return. In other words, this system allows business groups to offset losses with gains elsewhere in the business groups. We expect that firms that use the consolidated taxation system are more tax aggressive. Our tax aggressiveness measures are constructed based on individual tax returns even when the firms use the consolidated taxation system. Thus, our results are not affected by the introduction of the consolidated tax filing.

[70] The target of the BS data is corporations whose legal capital is 30 million yen or larger and whose number of employees is 50 or more. The BS data impose a restriction on the target companies in terms of the number of employees while the FS data do not. Firms used in the analysis are relatively large, and therefore this restriction on the BS data is not relevant when merging these two datasets. The BS data cover companies in almost all non-financial industries, with some exceptions such as those in the construction industry, while the FS data cover companies in all non-financial industries.

[71] We match the FS data with the BS data based on legal capital, assets, and sales. We adopt a similar data matching procedure with what we have used when merging the FS data with FinancialQUEST.

[72] The Japanese tax system allows firms to deduct past tax losses from their current or future corporate taxable income like in many other countries. We include a past loss dummy variable in the regression as a control variable. The time span for loss carryforwards changed over time as follows: five years up to 2003; seven years between 2004 and 2010; and nine years in 2011 and afterwards.

current before-tax profits and corporate tax liabilities are positive. This data restriction is necessary to define book tax differences, which will be discussed later. We keep observations whose lagged assets are non-missing since this variable is used as a denominator of some variables in regression such as leverage. We then replace missing values with zero.[73] All variables used in regression are winsorized at 1% levels and at 99% levels.

The final sample consists of 39976 firm-year observations. The number of public observations is 22959, and that of private observations is 17017. Thus, 42.6% of the observations are private. This percentage is smaller than that reported in Hanlon, Mills, and Slemrod (2007), which is 58.5%. One reason behind this difference in the data composition is that we keep observations with positive before tax income, while Hanlon, Mills, and Slemrod (2007) do not impose this restriction. In our data, non-positive profits are less common among public observations than private observations. As a result, private companies are less prevalent in our data than in their data. This observation suggests that public companies' managers engage in earnings management to avoid reporting non-positive profits, in line with our discussion below.

During the entire data periods, 20849 observations stay public, and 15979 observations stay private. The remaining 3148 observations experienced a change either from private to public or from public to private during the data periods. Therefore, we observe a considerable within-firm variation in stock listing or stock delisting. This within-firm variation plays key roles for identification. First, we use the firm-fixed effect models. Thus, we need a within-firm variation. Second, we use some firms that have changed from public to private as the treatment group in a quasi-natural experiment.

3.2. Identification strategy

We use a quasi-natural experimental research design with an IV strategy. The treatment in this experiment is two legal reforms that cause delisting among public subsidiaries, which will be explained in detail below. The treatment group consists of all subsidiaries that were public before the legal reforms because they have the potential to delist their stocks. The control group consists of subsidiaries that are private during the entire data periods because these companies are not

[73] We interpolate missing values or zero for parent companies' ownership ratio in the BS data. We first replace missing values with zero when we observe only either missing values or zeros during the entire data periods for the firm. We then replace missing values or zeros with the average value of previous period's value and the next period's value when these two values are exactly the same or the difference of these two values is 0.1 percentage point. We treat the remaining zeros as missing values, and we drop these observations. Main findings are not affected by this interpolation.

affected by the treatment that causes delisting. A concern in this research design is that not all public subsidiaries delisted stocks, which leads to a selection problem. We use an IV approach to deal with this endogeneity.

Our identification strategy takes advantages of a series of corporate law reforms around 2000. These reforms involve fundamental changes in legal environments which Milhaupt (2006) calls a "sea change". Two of the legal reforms allow parent companies to forcibly eliminate (or squeeze out) their subsidiaries' minority shareholders. These reforms are important to our paper since they provide an exogenous variation in stock listing. The first legal reform is the share exchange system introduced in 1999. This system provides parent companies legal rights to eliminate their subsidiaries' minority shareholders by granting the parent companies' stocks to their subsidiaries' minority shareholders. In other words, squeeze out is implemented by exchanging parents' stocks with their subsidiaries' stocks. The second reform is an introduction of a class shares subject to wholly call system introduced in 2006. This legal system has similar economic function to the share exchanges for the purpose of squeeze out.[74]

If these reforms are effective, we expect to see a considerable change in ownership structures of Japanese business groups after 1999. More specifically, a large number of partly owned subsidiaries should have changed into wholly owned subsidiaries as a result of the legal reforms that have made squeeze out less costly. When companies change from partly owned subsidiaries to wholly owned subsidiaries, these subsidiaries must delist their stocks from stock exchanges because of the limited supply of their stocks on markets.[75] Therefore, this change in ownership will increase the number of subsidiaries that go from public to private. This is the variation in stock delisting we use in the quasi-natural experiment.

It is questionable, however, whether this delisting can be treated as an exogenous variation because not all partly owned subsidiaries are squeezed out. In other words, there is a concern about

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[74] The outline of the legal procedure for squeeze out through the class shares subject to wholly call system is as follows. Companies first alter their articles of incorporation at the shareholders meetings, and all the common stocks are changed into class shares subject to wholly call. Next, the companies acquire all stocks from the shareholders. The companies redeem shares in a way that their minority shareholders receive shares less than one unit. This procedure leaves the minority shareholders with no alternative but to receive cash in exchange of their stocks. As a result, the minority shareholders are squeezed out.

[75] At least 5% of stocks must be traded for firms to stay listed at Tokyo Stock Exchange, which is the largest stock exchanges in Japan. Tokyo Stock Exchange has additional regulations that restrict subsidiaries whose parents' ownership is high to list their stocks.

a selection bias. Institutional details of the legal systems provide an exogenous source of variation in the likelihood concerning which subsidiaries are to be squeezed out. Using this information, we can construct an instrument to explain the cross sectional variation in squeeze out after the legal reforms. In principal, these two legal systems require extraordinary resolution that must be passed by a 2/3 of the vote casts at shareholders meetings of both acquirers and acquired companies.[76] Thus, it is sufficient for parents to own 2/3 of their subsidiaries' stocks to eliminate the subsidiaries' minority shareholders. If the parents' ownership is lower than 2/3, they need to issue tender offers before using the legal systems. This two-stage strategy in squeeze out is common in practice. For example, Panasonic squeezed out Sanyo in 2011 following this two-stage procedure. Sanyo was one of Panasonic's partly owned, public subsidiaries. Panasonic's ownership of Sanyo was 50.2% in 2010 March. Panasonic issued a tender offer during 2010, and its ownership became 80.1% in 2010 December. Panasonic then exploited the share exchanges, and Sanyo became a wholly owned subsidiary of Panasonic in 2011 April. Sanyo delisted their stock as a result of this process.

The possibility of using this two-stage strategy allows us to construct an instrument of a private observation dummy variable. The private observation dummy takes one when the observation is private. The literature demonstrates that tender offers involve a considerable amount of takeover premium. For example, Rossi and Volpin (2004) report that the average takeover premium is 40%. Therefore, total takeover premium that parents are required to pay at the first stage of the two-stage strategy is a decreasing function in their ownership. Our argument implies that the likelihood that the subsidiaries are squeezed out is kinked at 2/3 ownership, and this function is flat beyond this threshold because 2/3 ownership is sufficient to pass proposals for squeeze out at the shareholders meetings.

We construct an instrument based on this idea.[77] The instrument takes zero for all observations before the legal reforms in squeeze out. Thus, a variation in the instrument is observed only after the legal reforms. The instrument can take non-zero values only when the observations were public

[76] There is an exception to this rule. When the target subsidiaries are considerably smaller than the parents, the extraordinary resolution at acquirers' shareholders meetings can be bypassed when using the share exchanges. Specifically, this simplified share exchange system is available when parent companies' net worth is at least five times as large as these parents' payments to the subsidiaries' minority shareholders.

[77] We can also exploit the condition for which parent companies can follow the simplified share exchanges explained in the previous footnote to construct an instrument. These parents can save costs associated with the regular share exchange procedures such as legal fees. Thus, we expect that subsidiaries of these parents are more likely to be squeezed out. Using this information as an instrument generates similar estimation results.

subsidiaries before the legal reforms, that is, only when the firms are in the treatment group. This is because the purpose of using the instrument is to explain the variation in stock delisting among firms in the treatment group. Thus, the instrument can take non-zero value only after the legal reforms and only when the firms are in the treatment group.

The instrument cannot be time-dependent after the subsidiaries in the treatment group delist their stocks. For example, if we choose the subsidiaries' lagged ownership ratio as an instrument, this instrument is increased to 100 if the subsidiaries become private as a result of being squeezed out. Therefore, this instrument and the private dummy variable can exhibit a mechanical, positive correlation after being squeezed out. Using this instrument brings another problem because parent companies can adjust their subsidiaries' ownership stakes some years before using the legal systems. This ownership adjustment creates a positive correlation between this instrument and the private observation dummy before being squeezed out.

We construct an instrument to avoid these issues. We evaluate the ownership ratio of the subsidiaries in one year before the introduction of the legal reforms. This instrument captures the likelihood that the public subsidiaries are squeezed out when the legal systems are not available. As long as the legislation of these systems is not anticipated, parent companies do not have incentives to adjust ownership of their subsidiaries before the reforms. According to the following newspaper articles, official discussions on the introduction of the legal systems started in 1998 July. The Nikkei on July 9, 1998 reported that the commercial law committee of the legislative council of the Ministry of Justice released an interim report suggesting an introduction of the share exchange system. The Nikkei on November 26, 1998 reported that the government decided to introduce the share exchanges in 1999. Therefore, the legal reform might have been anticipated one year before the actual introduction of the legal system. Although the main IV regression uses 1998 as the year to evaluate the ownership ratio, we alternatively use the information of two or more years before the legal reforms to construct an instrument to check the robustness of our findings.

Because of the unbalanced panel structure, which is relatively salient in the context of tax aggressiveness since we remove observations with non-positive profits, we may not know the ownership ratio in 1998. In this case, we use the ownership ratio in 1997. We repeat this procedure when the ownership of the year of interest is not observed. Another issue raised from the unbalanced panel structure is that we cannot classify subsidiaries that exist only in 1999 and afterwards either into the treatment group or into the control group because the group classification is based on information before the legal reforms. We remove these subsidiaries from the sample used for the quasi-natural experiment.

Another concern about this research design is that the instrument reflects information of past ownership structures before the legal reforms. This IV strategy might violate the exclusion restriction because we argue that ownership is a factor that can affect tax aggressiveness. In addition, there exists a qualitative difference between subsidiaries included in the treatment group and those in the control group. This is because subsidiaries in the treatment group are listed and thus their ownership structure is likely to be more dispersed than that in the control group. We include the contemporaneous ownership ratio as a control variable to mitigate these concerns. There remains a possibility that past ownership has direct impacts on the current level of tax aggressiveness even after controlling for the contemporaneous effects. We conduct falsification tests by regressing past ownership on current tax aggressiveness using the data periods before the introduction of the legal reforms. Insignificant estimates from this test provide support that the exclusion restriction is not violated.

3.3. Estimation model and variable definition

We turn to the explanation of estimation models. The main independent variable is a private company dummy variable, which takes one when the observation is private. Since stock market listing is firms' choice, we instrument this variable as we have discussed in the previous subsection. The literature uses a book tax difference to evaluate corporate tax aggressiveness. A standard book tax difference is defined by income before taxes minus estimated taxable income, which is tax liabilities divided by corporate tax rates, normalized by lagged assets (Manzon and Plesko (2002)). Larger Manzon and Plesko book tax difference (MP book tax difference) implies that the firms pay less corporate taxes relative to their accounting profitability. Thus, firms take an aggressive tax position when the MP book tax difference is large.

Recent studies do not necessarily accept the MP book tax difference as an adequate measure of corporate tax aggressiveness. This is because public companies' managers have incentives to manage earnings to exceed analysts' forecasts. Therefore, earnings management can increase the MP book tax difference in the absence of tax avoidance. Isolating the earnings management effects from the MP book tax difference is especially important for our purpose because analysts do not generally make forecasts of private companies' performance. Even when forecasts of private companies are available, a lack of publicly observable stock prices provides private companies' managers weaker incentives to manage earnings than public companies' managers. As a result, earnings management affects public companies' MP book tax difference more than private companies' MP book tax difference.

To eliminate the earnings management effects from the MP book tax difference, we use another type of book tax difference that was first introduced by Desai and Dharmapala (2006). Desai and Dharmapala book tax difference (DD book tax difference) removes the earnings management effects from the MP book tax difference to isolate the tax avoidance effects. More specifically, Desai and Dharmapala (2006) first regress the MP book tax difference on total accruals with firm-fixed effects, where total accruals measure the degree to which firms can manage earnings.[78] The residuals from this regression are the DD book tax difference. Formally, Desai and Dharmapala (2006) use the regression represented by

$$\mathrm{MPBTD}_{\mathrm{it}} = \beta \mathrm{TotalAccrual}_{\mathrm{it}} + \mu_{\mathrm{i}} + \varepsilon_{\mathrm{it}}$$

where index i represents company, index t represents year, MPBTD is the MP book tax difference, TotalAccrual is total accruals, μ is firm-fixed effects, and ε is error terms. The DD book tax difference is the residuals from this regression. Larger DD book tax difference implies that the observations are more tax aggressive. Our argument implies that the DD book tax difference is the most appropriate measure of corporate tax aggressiveness especially in our context, and thus we use this variable as the dependent variable in regression.

This paper uses three estimation techniques. First, we use cross sectional regression. We observe a considerable cross sectional variation in stock market listing. Thus, starting with cross sectional regression is a useful step to understand our topic of interest. In addition, since three of the closely related papers (Hanlon, Mills, and Slemrod (2007); Chen, Chen, Cheng, and Shevlin (2010); and Chyz, Leung, Li, and Rui (2013)) use only cross sectional regression, this analysis

[78] This paper defines total accruals based on the balance sheet approach suggested by Hribar and Collins (2002). This variable is defined by ((change in current assets) - (change in cash) - (change in current liabilities) + (change in short term debt) - depreciation) divided by lagged assets.

allows us to compare our results with those in previous studies. Second, we use firm-fixed effect models. This framework mitigates concerns that an observed correlation between stock market listing and tax aggressiveness is caused by time-invariant, firm-level heterogeneity. Some of the related studies in tax aggressiveness use firm-fixed effect models (Desai and Dharmapala (2006, 2009b)). This framework also allows us to examine the robustness of Hanlon, Mills, and Slemrod (2007)'s findings where only cross sectional regressions are used. The cross sectional model and the firm-fixed effect model are represented by

$$\mathrm{TA}_{\mathrm{it}} = \beta_1 \mathrm{Priate}_{\mathrm{it}} \times \mathrm{Sub}_{\mathrm{it}} + \beta_2 \mathrm{Private}_{\mathrm{it}} + \beta_3 \mathrm{Sub}_{\mathrm{it}} + \gamma \mathrm{X}_{\mathrm{it}} + \mu_{\mathrm{i}} + \eta_{\mathrm{jt}} + \epsilon_{\mathrm{it}} \quad (1)$$

where index i represents company, index t represents year, index j represents industry, TA is DD book tax difference, Sub is a subsidiary dummy variable, Private is a private company dummy variable, X is a matrix that includes various control variables that are explained below, μ represents firm-fixed effects and μ does not depend on i when we use cross sectional models, η is industry-year fixed effects, and ε is error terms.

β_1 evaluates whether private observations are more tax aggressive than public observations given that the firms' ownership is concentrated. We expect a positive sign on this estimate. β_2 tests whether tax aggressiveness depends on stock market listing when the ownership is not concentrated. To compare our results with Hanlon, Mills, and Slemrod (2007)'s results, we run regression (1) without Private×Sub or Sub. This model estimates the average differences in tax aggressiveness between public observations and private observations. We use robust standard errors clustered at the firm level.

The third methodology takes advantages of the legal reforms in squeeze out that provide an exogenous variation in stock market delisting. This methodology seeks to eliminate a potential bias in OLS estimates associated with endogeneity of stock market listing. For example, corporations that are planning to go from private to public typically sign a multi-year contract with accounting firms to prepare for listing their stocks. These private companies are likely to have various opportunities to learn tax avoidance schemes from the accounting firms. As a result, newly listed companies can be more likely to be tax aggressive. OLS estimates on private company dummy exhibits an upward bias in this case. The third methodology uses a difference-in-differences framework with the IV method explained above to mitigate endogeneity concerns.

A difference in the data composition between the previous two methodologies and this third methodology is that the former two models include all firms while the latter includes only subsidiaries because the legal reforms used in the third methodology are relevant only for subsidiaries. We use both cross sectional models and firm-fixed effect models in this third methodology to compare our results with those obtained from the non-experimental framework. The first stage regression and the second stage regression are respectively represented by

$$\mathrm{Private}_{it} = \delta \mathrm{Past\ ownership\ IV}_{it} + \gamma X_{it} + \mu_i + \eta_{jt} + \epsilon_{it} \quad (2)$$

$$\mathrm{TA}_{it} = \beta \widehat{\mathrm{Private}}_{it} + \gamma X_{it} + \mu_i + \eta_{jt} + \epsilon_{it} \quad (3)$$

where equation (2) is the first stage regression, equation (3) is the second stage regression, index i represents company, index t represents year, index j represents industry, Private is a private company dummy variable, Past ownership IV is ownership ratio evaluated principally in 1998 that is capped at 66.67, X is a matrix that includes various control variables that are explained below, μ represents firm-fixed effects and μ does not depend on i when we use cross sectional models, η is industry-year fixed effects, ε is error terms, TA is DD book tax difference, and $\widehat{\mathrm{Private}}$ is imputed value of Private from the first stage regression.

The X matrix in the third methodology includes a treatment dummy variable, which takes one when the subsidiaries are in the treatment group, in addition to other variables. This group dummy is absorbed by the firm-fixed effects when including them in regression, while the group dummy can be estimated in the cross sectional models. Note that Private×Treat is redundant as an independent variable because a variation in stock market listing is observed only among firms in the treatment group and we include the treatment dummy in regression. In other words, a variation in Private×Treat is identical to that in Private in the regression models. We use robust standard errors clustered at the firm level.

Control variables included in the X matrix are taken from related studies such as Chen, Chen, Cheng, and Shevlin (2010). These variables are as follows: leverage that is liabilities divided by lagged assets; profitability that is operating profit divided by lagged assets; PPE that is fixed tangible assets divided by lagged assets; intangibility that is intangible assets divided by lagged assets; log of lagged assets; and accumulated loss dummy that takes one when firms' before tax income aggregated across the past five years is negative. We also include contemporaneous ownership ratio. Furthermore, we include an industry-year dummy to absorb industry-year level economic shocks.

We include these control variables for the following reasons. Leverage captures the degree of available debt tax shields. This aspect of leverage makes firms with a higher level of leverage more tax aggressive. However, in our context, leverage is also likely to capture differences in financing environments because only public companies' stocks are traded at stock exchanges. Thus, signs of leverage coefficients are not theoretically clear. Profitability is expected to be positively associated with tax aggressiveness because profitable firms have larger before tax income, and therefore they have a stronger incentive to avoid taxes. PPE captures capital intensity, which reflects the importance of the different treatments of depreciation between in tax statements and in financial statements. Highly capital intensive firms have an incentive to take tax avoidance measures, and therefore we expect a positive association between PPE and tax aggressiveness. Intangibility is expected to be positively associated with tax aggressiveness because firms with high intangibility can engage in income shifting for tax benefits more easily. The accumulated loss dummy is expected to be positively associated with tax aggressiveness because firms with past losses can deduct them from their current taxable income. Parents' ownership captures monitoring intensity as we have discussed.

Table 14 reports mean and standard deviation of individual variables used in regression. We separately report the statistics among public companies and among private companies. The second row shows that 11% of the public observations are subsidiaries. These observations play key roles in identification given that the treatment group in the quasi-natural experiment consists of subsidiaries that were public before 1999. This table supports the argument that private observations are more concentrated than public observations as we have presumed; the parent's average ownership is 61.9% among private observations, and it is 7.1% among public observations. There is also a large difference in leverage between public observations and private observations. Private observations are 16 percentage points more highly leveraged than public observations. This difference in leverage is likely to reflect a difference in cost of capital since only public companies have access to the public equity market (Brav (2009)).[79]

4. Result

4.1. Non-experimental framework

We first present estimation results under the non-experimental framework. Although regression based on this framework can suffer from endogeneity associated with the choices to list stocks, these models are useful to compare our results with those in related studies, especially those in Hanlon, Mills, and Slemrod (2007). We can also compare estimation results from this framework with those from the experimental framework. This comparison can highlight the advantages of the quasi-natural experiment especially when we obtain different estimation results from different frameworks.

Table 15 shows estimation results under the non-experimental framework. Columns (1) – (4) use the cross sectional models. Columns (5) – (8) use the firm-fixed effect models. Even numbered columns include the parent's ownership ratio as a control variable. Columns (3), (4), (7), and (8) include the subsidiary dummy as well as the interaction term of the private dummy and the subsidiary dummy. All the models are estimated using the OLS.

Private coefficient in column (1) shows that private companies are more tax aggressive than public companies on average, without considering the ownership structures. This result is qualitatively the same with that reported in Hanlon, Mills, and Slemrod (2007). In contrast, we observe a quantitative difference in the magnitude of the estimates. Table 5 in Hanlon, Mills, and Slemrod (2007) reports that the coefficients on private observation dummy on their tax aggressiveness measure are 0.0011 - 0.0013, depending on the measure's denominator that is either sales or assets. Table 4 of their paper reports that the standard deviation of their tax aggressiveness measures is 0.0055 - 0.0068. Thus, stock market listing decreases tax aggressiveness by about 0.2 standard deviations of the dependent variables. Our estimates of 0.059 in column (1) imply that stock market listing makes 0.03 standard deviation differences in tax aggressiveness, given that the standard deviation of the DD book tax difference is 2.03 in our paper. Hanlon, Mills, and Slemrod (2007) use the Tobit model, but a crude comparison between their estimates and our

[79] This difference in leverage between public observations and private observations is consistent with Brav (2009)'s finding in the U.K. Brav (2009) reports that the difference in leverage is 10 percentage points. Thus, the difference in leverage between public companies and private companies is larger in Japan than in the U.K.

estimates in column (1) implies that our estimates are 3/20 of their estimates in magnitude.[80]

This result from column (1) is not robust under the non-experimental framework. Column (2) shows that the sign of the private coefficient has been reversed after controlling the parent's ownership ratio. Although column (3) shows that private observations are more tax aggressive than public observations when the ownership is concentrated, the statistical significance disappears when we control the parent's ownership ratio in column (4). These results imply that ownership structures are important factors behind the correlation between stock market listing and tax aggressiveness. This result is in line with recent finding that ownership structures play key roles in the relationship between agency conflicts and tax aggressiveness (Desai and Dharmapala (2006)).

Our estimation results with the firm-fixed effects provide clearer evidence that the finding from column (1) is not robust. All the models with firm-fixed effects show that neither the coefficients on the private dummy, the subsidiary dummy, nor the interaction term of these two variables are statistically significant. One possible implication of this result is that the finding by Hanlon, Mills, and Slemrod (2007) is not robust when we control firm-heterogeneity. Alternatively, we can interpret that this insignificance is a consequence of endogeneity of stock market listing. We provide evidence based on the experimental framework to address the endogeneity in the next subsection.

4.2. Experimental framework

4.2.1. Main finding

Tables 16 and 17 present estimation results under the experimental framework. Note that the number of observations decreases to 8432 because we only include subsidiaries in the experimental framework. The treatment group consists of 1866 observations and the control group consists of

[80] The sign of other independent variables is broadly consistent with our predictions as well as with the sign reported in the previous studies such as Chen, Chen, Cheng, and Shevlin (2010). PPE, intangibility, and past accumulated losses have positive impacts on tax aggressiveness. This is in line with Chen et al. (2010)'s findings in Panel A of Table 4 of their paper. Firm size measured by lagged assets is positively associated with tax aggressiveness, which suggests that larger firms have more opportunities to avoid taxes. However, the sign is reversed when we include firm-fixed effects. The negative sign of the leverage coefficient is not consistent with our prediction based on the tax benefits of debt. In our context, leverage is likely to capture the difference in financing environments between public companies and private companies because only public companies have access to public equity markets. Thus, this coefficient might not have clear interpretation compared to previous studies. The negative sign on profitability coefficient is inconsistent with our prediction as well as with Chen et al. (2010)'s finding. However, the statistical significance of the coefficient disappears when we include firm-fixed effects. Furthermore, we obtain positive and significant estimates when we use the experimental framework as we will show below.

6566 observations. Among the observations in the treatment group, 327 observations are private companies.

Table 16 presents the first-stage results to explain which factors affect the firms' decisions to go private. Column (1) uses the cross sectional framework, and column (2) includes firm-fixed effects. The F-statistic of the excluded instrument is 35.64 in column (1) and it is 34.31 in column (2). Therefore, the instruments are sufficiently strong. The sign of the past ownership IV coefficients are positive and significant at the 1% level in both models. Therefore, subsidiaries are more likely to be squeezed out when their parent's past ownership is higher. Since our models include the parent's current ownership ratio as a control variable, this table provides evidence that the past ownership itself explains a variation in stock delisting.

Table 17 presents second stage estimation results of the IV strategy. Columns (1) and (2) use the cross sectional models. Columns (3) and (4) use the firm-fixed effect models. We use the IV strategy for columns (1) and (3). We use OLS for columns (2) and (4) for comparison.

The cross sectional models show that private observations are more tax aggressive than public observations. This finding is consistent with our prediction. A notable difference between the IV estimates and the OLS estimates is their magnitude; it is 1.65 under the IV strategy, and it is 0.60 under the OLS. Models including firm-fixed effects provide a sharper contrast between in OLS estimates and in IV estimates. Private coefficient is insignificant in the OLS model, while it is positive and significant in the IV model. Thus, our IV strategy provides consistent evidence that stock market listing reduces tax aggressiveness.

The estimate of 2.22 of the imputed private dummy in column (3) suggests that stock market listing has economically significant impacts on tax aggressiveness. The magnitude of this estimate implies that the difference in tax aggressiveness between public companies and private companies is more than one standard deviation of the DD book tax difference (2.03). We can interpret that the estimate is five times larger than that reported in Table 5 in Hanlon, Mills, and Slemrod (2007) if we measure the estimate by the standard deviation of the dependent variable. Therefore, we find a sizable impact of stock market listing on tax aggressiveness, compared to that found in Hanlon, Mills, and Slemrod (2007).

4.2.2. Robustness

In this subsection, we discuss concerns that may cause biases in IV estimates: weak instruments and a violation of exclusion restrictions. We have provided evidence that the instrument is strong by showing that F-statistic of the excluded instrument is over 10 in Table 16. To support the hypothesis that the exclusion restriction is not violated, we conduct two tests that show past ownership does not predict current tax aggressiveness.

The first test uses the data periods before the introduction of the legal systems for squeeze out. Without the legal systems, the indirect effect of the parent's past ownership on tax aggressiveness through a change in the costs for squeeze out does not exist. Therefore, zero coefficients on the past ownership IV when we use the data periods before the legal reforms provide support for the hypothesis that the exclusion restriction is not violated. Specifically, we restrict the data periods from 1994 to 1998, from 1994 to 1997, and from 1994 to 1996, respectively. Using a sample that consists of each of the data periods, we estimate the equation represented by

$$\mathrm{TA}_{\mathrm{it}} = \delta \text{Past ownership } \mathrm{IV}_{\mathrm{it-n}} + \gamma \mathrm{X}_{\mathrm{it}} + \mu_{\mathrm{i}} + \eta_{\mathrm{jt}} + \epsilon_{\mathrm{it}}$$

where index i represents company, index t represents year, index j represents industry, index n represents the number of lags of the past ownership IV that is the ownership ratio capped at 66.67, TA is the DD book tax difference, X is a matrix that includes control variables, μ represents firm-fixed effects and μ does not depend on i when we use cross sectional models, η is industry-year fixed effects, and ε is error terms.

Table 18 reports coefficients on the past ownership IV. The first row represents the data periods and the first column represents the number of lags of the past ownership IV. In each year period, we use both cross sectional models and firm-fixed effect models. Regression includes other covariates, but we do not report their estimates for simplicity of exposition. Note that each regression includes only one of the past ownership IV variables. For example, the second column of this table does not mean that we include four past ownership IV variables at the same time.

Table 18 shows that 13 of the 15 estimates of the past ownership IV coefficients are not statistically significant. Two of the models exhibit negative, significant estimates at the 5% level when we use one-year lagged past ownership IV. These results suggest that the exclusion restriction is not violated as long as we use two or more years lagged ownership as the instrument. These findings also cause a concern that our estimates reported in Table 17 are biased. This is because we use the parent's ownership ratio evaluated in one-year before the legal reforms as the instrument. Consequently, the exclusion restriction might have been violated among subsidiaries that are squeezed out in 1999.

The second test to examine the possibility of a violation of the exclusion restriction is related to this point. The base IV regression uses past ownership evaluated principally in 1998 as the instrument. This choice of the year can be problematic as suggested in the previous paragraph. In addition, we have discussed that the introduction of the share exchanges might have been anticipated at least one year before its actual introduction. This implies that parents might have started to adjust ownership stakes of their subsidiaries before their actual introduction. Therefore, we evaluate the past ownership structure in over one year before 1999 to construct the instruments. We estimate equations (2) and (3) using the instruments. When the data do not tell the ownership ratio of the year of interest (for example, 1997) due to the unbalanced panel structures, we use one year before the year (that is, 1996) as we have conducted in our main IV regression.

Table 19 shows the estimation results. Columns (1) - (2), (3) - (4), (5) - (6), and (7) - (8) respectively evaluate the past ownership ratio principally in 1997, 1996, 1995, and 1994. Odd numbered columns use the cross sectional models, and even numbered columns include the firm-fixed effects.

All the models show that the estimates of the imputed private dummy coefficients are positive and statistically significant at least at the 10% level. Estimates from the firm-fixed effect models are consistently significant at the 5% level. F-statistic of the excluded instruments is over 30 across all columns. Therefore, the instruments are strong when we use older information to construct the instruments as well. It is noteworthy that the F-statistic is relatively large when we use older information such as that in 1996. This observation can suggest that the estimates from these models using older information might be more reliable to evaluate the economic significance.

From Tables 17 and 19, the estimates of the imputed private dummy variable range from 1.17 to 2.22. These estimates correspond to 0.58 – 1.09 standard deviations of the DD book tax difference. The 0.58 standard deviation differences are more than twice as large as those found in Hanlon, Mills, and Slemrod (2007) based on the crude comparison. From the discussion in this subsection, we confirm that the impacts of stock market listing on tax aggressiveness are considerably larger than previously documented.

5. Conclusion

The existing firm-level variation in corporate tax aggressiveness has been puzzling in public economics and corporate finance. Recent literature focuses on agency conflicts in corporations as a crucial factor that reduces managerial incentives to take tax aggressive measures. Few studies have examined how the scrutiny from stock markets affects tax aggressiveness due to difficulties in having access to data that cover both public companies and private companies. We use unique datasets of Japanese corporations to test whether agency costs associated with stock market listing reduce tax aggressiveness.

A challenge in estimation is that stock market listing is a firms' choice. To mitigate this endogeneity concern, we use legal reforms in squeeze out as a quasi-natural experiment. Our main models compare observations that changed from public subsidiaries to private subsidiaries as a result of these legal reforms. We also use subsidiaries that were private before the legal reforms as the control group. Therefore, this paper takes a difference-in-differences approach. Furthermore, we deal with the selection problem concerning which subsidiaries are to be squeezed out using an IV strategy.

We show that private companies are more tax aggressive than public companies among subsidiaries. This result is consistent with our prediction. We also provide evidence that the instrument is strong and that the exclusion restriction is not violated. Our findings suggest that stock markets monitor corporate tax avoidance. In other words, financial developments can encourage corporations to pay taxes. Our findings also imply that closer supervision over private companies can be necessary because private companies have stronger incentives to be tax aggressive than public companies.

Table 14
Summary statistics

This table separately reports summary statistics among public observations, among private observations, and among total observations. The data periods are between 1994 and 2012. Private dummy is a variable that takes one when the observation is a private company. Subsidiary dummy is a variable that takes one when the firm's majority of shares are held by another company (parent company). Parent's ownership is the ownership ratio of the parent company when the observation has a parent. This value is zero when the observation does not have a parent. Leverage is liabilities divided by lagged assets. Profitability is operating profit divided by lagged assets. PPE is fixed tangible assets divided by lagged assets. Intangibility is intangible assets divided by lagged assets. Ln(assets) is natural log of lagged assets. Past loss dummy is a variable that takes one when firms' before tax income aggregated across past five years is negative. DD (Desai-Dharmapala) book tax difference is the residuals from the regression of MP (Manzon-Plesko) book tax difference on total accruals and firm-fixed effects. MP book tax difference is before tax profits minus estimated taxable income, which is corporate tax liabilities divided by corporate income tax rates, divided by lagged assets.

	Public observation (22959 observations)		Private observation (17017 observations)		Total observation (39976 observations)	
	mean	sd	mean	sd	mean	sd
Private dummy	0.00	0.00	1.00	0.00	0.43	0.49
Subsidiary dummy	0.11	0.32	0.70	0.46	0.36	0.48
Parent's ownership	7.05	18.94	61.94	42.82	30.42	41.51
Leverage	49.51	21.03	65.51	24.02	56.32	23.71
Profitability	4.89	4.10	5.40	5.17	5.10	4.59
PPE	27.94	15.84	32.60	21.18	29.93	18.45
Intangibility	0.81	1.44	0.87	1.84	0.84	1.63
Ln(assets)	10.71	1.33	9.93	1.17	10.38	1.32
Past loss dummy	0.13	0.34	0.17	0.37	0.15	0.35

Table 15

Estimation results from the non-experimental framework

This table presents estimation results to examine whether private observations are more tax aggressive than public observations. The data periods are between 1994 and 2012. We use the entire sample. We use OLS for estimation. The dependent variable that measures tax aggressiveness is DD (Desai-Dharmapala) book tax difference. DD book tax difference is the residuals from the regression of MP (Manzon-Plesko) book tax difference, which is before tax profits minus estimated taxable income (that is corporate tax liabilities divided by corporate income tax rates) divided by lagged assets, on total accruals and firm-fixed effects. Private dummy is a variable that takes one when the observation is a private company. Subsidiary dummy is a variable that takes one when the firm's majority of shares are held by another company (parent company). Parent's ownership is the ownership ratio of the parent company when the observation has a parent. This value is zero when the observation does not have a parent. Leverage is liabilities divided by lagged assets. Profitability is operating profit divided by lagged assets. PPE is fixed tangible assets divided by lagged assets. Intangibility is intangible assets divided by lagged assets. Ln(assets) is natural log of lagged assets. Past loss dummy is a variable that takes one when the firms' before tax income aggregated across past five years is negative. Standard errors reported in parentheses are clustered at the firm-level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 15 - Continued

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	DD book tax difference							
Private dummy× Subsidiary dummy			0.193***	0.091			-0.158	-0.082
			(0.053)	(0.063)			(0.209)	(0.237)
Private dummy	0.059**	-0.063**	-0.092***	-0.093***	0.052	0.098	0.134	0.139
	(0.027)	(0.030)	(0.032)	(0.032)	(0.110)	(0.126)	(0.157)	(0.158)
Subsidiary dummy			0.038	-0.155**			0.274	0.297
			(0.043)	(0.073)			(0.231)	(0.235)
Parent's ownership		0.002***		0.003***		-0.002		-0.002
		(0.000)		(0.001)		(0.003)		(0.004)
Leverage	-0.004***	-0.004***	-0.004***	-0.004***	-0.008***	-0.008***	-0.008***	-0.008***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Profitability	-0.012**	-0.014***	-0.014***	-0.014***	-0.005	-0.005	-0.005	-0.005
	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)
PPE	0.002**	0.002***	0.002***	0.002***	0.005**	0.005**	0.005**	0.005**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Intangibility	0.029***	0.028***	0.028***	0.028***	0.065***	0.065***	0.065***	0.065***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.020)	(0.020)	(0.020)	(0.020)
Log(assets)	0.090***	0.092***	0.091***	0.091***	-0.532***	-0.532***	-0.528***	-0.529***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.074)	(0.074)	(0.074)	(0.074)
Past loss dummy	1.621***	1.615***	1.617***	1.614***	1.178***	1.178***	1.178***	1.178***
	(0.062)	(0.062)	(0.062)	(0.062)	(0.057)	(0.057)	(0.057)	(0.057)
Firm-fixed effect	No	No	No	No	Yes	Yes	Yes	Yes
Industry-year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimation method	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Observations	39976	39976	39976	39976	39976	39976	39976	39976

Table 16

Estimation results from the experimental framework: The first stage estimation

This table presents the first stage estimation results of the IV strategy to examine whether private observations are more tax aggressive than public observations. The data periods are between 1994 and 2012. The sample includes only subsidiaries. The dependent variable is private dummy, which is a variable that takes one when the observation is a private company. The past ownership IV is constructed from the parent's ownership ratio evaluated principally in 1998 that is capped at 66.67. The past ownership IV takes this ownership ratio when the subsidiaries are in the treatment group and the year periods are in 1999 and afterwards. Otherwise, the past ownership IV takes zero. Treatment dummy takes one in 1999 and afterwards if the firms were listed before 1999. Parent's ownership is the ownership ratio of the parent company when the observation has a parent. This value is zero when the observation does not have a parent. Leverage is liabilities divided by lagged assets. Profitability is operating profit divided by lagged assets. PPE is fixed tangible assets divided by lagged assets. Intangibility is intangible assets divided by lagged assets. Ln(assets) is natural log of lagged assets. Past loss dummy is a variable that takes one when firms' before tax income aggregated across past five years is negative. Standard errors reported in parentheses are clustered at the firm-level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)
	Private observation dummy	
Past ownership IV	0.003***	0.002***
	(0.000)	(0.000)
Treatment dummy	-0.832***	
	(0.020)	
Parent's ownership	0.004***	0.010***
	(0.000)	(0.001)
Leverage	0.000	0.000**
	(0.000)	(0.000)
Profitability	-0.001*	-0.001*
	(0.001)	(0.001)
PPE	-0.000**	-0.001**
	(0.000)	(0.000)
Intangibility	0.002	0.002
	(0.003)	(0.003)
Ln(assets)	0.002	-0.001
	(0.004)	(0.016)
Past loss dummy	0.011	0.016**
	(0.008)	(0.008)
Firm-fixed effect	No	Yes
Industry-year dummy	Yes	Yes
F-statistic of excluded instrument	35.64	34.31
Observations	8432	8432

Table 17

Estimation results from the experimental framework: The second stage estimation

This table presents the second stage estimation results of the IV strategy to examine whether private observations are more tax aggressive than public observations. The data periods are between 1994 and 2012. The sample includes only subsidiaries. We use OLS or IV for estimation. The dependent variable that measures tax aggressiveness is DD (Desai-Dharmapala) book tax difference. DD book tax difference is the residuals from the regression of MP (Manzon-Plesko) book tax difference, which is before tax profits minus estimated taxable income (that is corporate tax liabilities divided by corporate income tax rates) divided by lagged assets, on total accruals and firm-fixed effects. Imputed private dummy is a variable that is obtained from the first stage estimation. Treatment dummy takes one in 1999 and afterwards if the firms were listed before 1999. Parent's ownership is the ownership ratio of the parent company when the observation has a parent. This value is zero when the observation does not have a parent. Leverage is liabilities divided by lagged assets. Profitability is operating profit divided by lagged assets. PPE is fixed tangible assets divided by lagged assets. Intangibility is intangible assets divided by lagged assets. Ln(assets) is natural log of lagged assets. Past loss dummy is a variable that takes one when firms' before tax income aggregated across past five years is negative. Standard errors reported in parentheses are clustered at the firm-level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)
	DD book tax difference			
Imputed private dummy	1.653**	0.596***	2.219**	0.291
	(0.768)	(0.229)	(0.906)	(0.246)
Treatment dummy	1.225**	0.437**		
	(0.606)	(0.218)		
Parent's ownership	-0.005	-0.001	-0.023**	-0.002
	(0.004)	(0.002)	(0.010)	(0.004)
Leverage	-0.005***	-0.005***	-0.011***	-0.010***
	(0.002)	(0.002)	(0.002)	(0.003)
Profitability	0.016**	0.015*	0.021**	0.019
	(0.008)	(0.008)	(0.010)	(0.011)
PPE	0.008***	0.007***	0.005	0.004
	(0.002)	(0.002)	(0.005)	(0.005)
Intangibility	-0.003	-0.000	0.082*	0.088
	(0.031)	(0.032)	(0.050)	(0.055)
Ln(assets)	-0.018	-0.017	-0.408***	-0.405***
	(0.030)	(0.030)	(0.126)	(0.141)
Past loss dummy	1.767***	1.780***	1.531***	1.568***
	(0.100)	(0.102)	(0.113)	(0.123)
Firm-fixed effect	No	No	Yes	Yes
Industry-year dummy	Yes	Yes	Yes	Yes
OLS or IV?	IV	OLS	IV	OLS
Observations	8432	8432	8432	8432

Table 18

Robustness: Data periods before the legal reforms

This table presents estimation results to examine whether past ownership predicts current tax aggressiveness. We restrict the data periods to either 1994 - 1998, 1994 - 1997, or 1994 - 1996. The sample includes only subsidiaries. We use OLS for estimation. The dependent variable that measures tax aggressiveness is DD (Desai-Dharmapala) book tax difference. DD book tax difference is the residuals from the regression of MP (Manzon-Plesko) book tax difference, which is before tax profits minus estimated taxable income (that is corporate tax liabilities divided by corporate income tax rates) divided by lagged assets, on total accruals and firm-fixed effects. The past ownership IV is constructed from the parent's ownership ratio that is capped at 66.67. The past ownership IV takes this ownership ratio when the subsidiaries are in the treatment group and the year periods are in 1999 and afterwards. Otherwise, the past ownership IV takes zero. The number in the parenthesis added after the past ownership IV in the table refers to the number of lags of the past ownership IV (for example, (t-1) refers to one year lag). We include the following variables as other covariates, but we only report the estimates of the past ownership IV coefficients. Treatment dummy takes one in 1999 and afterwards if the firms were listed before 1999. Parent's ownership is the ownership ratio of the parent company when the observation has a parent. This value is zero when the observation does not have a parent. Leverage is liabilities divided by lagged assets. Profitability is operating profit divided by lagged assets. PPE is fixed tangible assets divided by lagged assets. Intangibility is intangible assets divided by lagged assets. Ln(assets) is natural log of lagged assets. Past loss dummy is a variable that takes one when firms' before tax income aggregated across past five years is negative. Standard errors reported in parentheses are clustered at the firm-level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	1994 – 1998		1994 - 1997		1994 – 1996	
Past ownership IV (t-1)	0.000	-0.071**	-0.002	-0.073**	-0.004	-0.081
	(0.010)	(0.031)	(0.010)	(0.031)	(0.013)	(0.091)
Past ownership IV (t-2)	0.010	0.035	0.008	0.002	0.001	
	(0.010)	(0.043)	(0.010)	(0.063)	(0.013)	
Past ownership IV (t-3)	0.014	0.023	0.022			
	(0.012)	(0.115)	(0.014)			
Past ownership IV (t-4)	0.014					
	(0.020)					
Other variables included	Yes	Yes	Yes	Yes	Yes	Yes
Firm-fixed effect	No	Yes	No	Yes	No	Yes
Industry-year dummy	Yes	Yes	Yes	Yes	Yes	Yes
OLS or IV?	OLS	OLS	OLS	OLS	OLS	OLS

Table 19

Robustness: Past ownership evaluated in before 1998

This table presents the second stage estimation results of the IV strategy to examine whether private observations are more tax aggressive than public observations. The data periods are between 1994 and 2012. The sample includes only subsidiaries. We use IV for estimation. The dependent variable of the first stage estimation is private dummy, which is a variable that takes one when the observation is a private company. The instrument is constructed from the parent's ownership ratio evaluated principally either in 1997, 1996, 1995, or 1994 that is capped at 66.67. This instrument takes this ownership ratio when the subsidiaries are in the treatment group and the year periods are in 1999 and afterwards. Otherwise, it takes zero. "Instrument evaluated year" in the table represents the year in which we principally evaluate the past ownership ratio. "F-statistic of excluded instrument" represents the F-statistic of the excluded instrument at the first stage estimation. In the second stage IV estimation, the dependent variable that measures tax aggressiveness is DD (Desai-Dharmapala) book tax difference. DD book tax difference is the residuals from the regression of MP (Manzon-Plesko) book tax difference, which is before tax profits minus estimated taxable income (that is corporate tax liabilities divided by corporate income tax rates) divided by lagged assets, on total accruals and firm-fixed effects. Imputed private dummy is a variable that is obtained from the first stage estimation. We include the following variables as other covariates (treatment dummy, parent's ownership, leverage, profitability, PPE, ln(assets), and past loss dummy), but we report only the estimates of the imputed private dummy coefficients. Treatment dummy takes one in 1999 and afterwards if the firms were listed before 1999. Parent's ownership is the ownership ratio of the parent company when the observation has a parent. This value is zero when the observation does not have a parent. Leverage is liabilities divided by lagged assets. Profitability is operating profit divided by lagged assets. PPE is fixed tangible assets divided by lagged assets. Intangibility is intangible assets divided by lagged assets. Ln(assets) is natural log of lagged assets. Past loss dummy is a variable that takes one when firms' before tax income aggregated across past five years is negative. Standard errors reported in parentheses are clustered at the firm-level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	DD book tax difference							
Imputed private dummy	1.480*	2.104**	1.408**	1.846***	1.171**	1.664**	1.244**	1.627**
	(0.770)	(0.901)	(0.566)	(0.645)	(0.578)	(0.658)	(0.582)	(0.659)
Other variables included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-fixed effect	No	Yes	No	Yes	No	Yes	No	Yes
Industry-year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
OLS or IV?	IV	IV	IV	IV	IV	IV	IV	IV
Instrument evaluated year	1997	1997	1996	1996	1995	1995	1994	1994
F-statistic of excluded instrument	36.87	34.27	71.43	85.27	63.20	79.22	60.24	74.39
Observations	8341	8341	8157	8157	8001	8001	7643	7643

CHAPTER 3: Taxes, stock ownership, and payout policy: Evidence from a 2011 tax reform in Japan[81]

1. Introduction

Recent studies provide evidence that tax incentives affect individual investors' stock holdings and trading (Poterba (2001, 2002)). The primary focus of these studies is on the behavior of households or retail investors, and little is known about whether taxes affect large individual investors' stock transactions. Studying this link is important because a change in stock holdings by large investors, which can be induced by a change in a tax code, has the potential to alter corporate policies (Cronqvist and Falenbrach (2009)). In his paper, we provide evidence that taxes affect stock trading and in turn change payout policy, using a tax reform in Japan.

The Japanese tax system makes a distinction between large individual shareholders (LISs) and non-large individual shareholders (non-LISs). LISs refer to individual shareholders who own 3% or higher stakes of the corporation under the tax system in 2012. This 3% threshold is effective after a 2011 October tax reform, and the threshold was 5% before this tax reform. Non-LISs' dividend income is taxed at a flat rate of 10%, while LISs' dividend income is taxed at progressive personal income tax rates. The top tax rate in 2012 is 43.6% after claiming a deduction for dividends. To avoid this tax increase, individual shareholders whose ownership is in between 3% to 5% have an incentive to sell stocks before 2011 October to restrict their ownership ratio below 3% after the tax reform. We test whether we observe this stock selling.

We take a triple-differences approach for this analysis, taking advantages of three characteristics of the tax reform. First, the tax reform applies only to individuals. Second, the tax reform changes marginal tax rates on dividends only when their ownership is in between 3% to 5%. Third, the tax reform reduces dividend tax rates, and therefore it affects investors' incentives only when the firms pay dividends. We construct dummies for each condition and use the interaction term of the three dummies as the main regressor.

We use Nikkei NEEDS Large Shareholder Database. This data set discloses information of the maximum of the top 30 largest shareholders of firms in Japan. There is no minimum ownership threshold under which firms need not disclose the ownership ratio of the large shareholders, such

[81] This chapter is the product of collaborative research with Kazuki Onji at Osaka University.

as the 5% ownership threshold in the U.S. We also use Nikkei NEEDS FinancialQUEST for financial information of individual companies. The main analysis uses the data in 2011 and 2012. The final sample consists of 23540 large investors and 1534 firms.

We find evidence that is consistent with our hypothesis. Over a half of the individual investors that are affected by the tax reform sell stocks so that they can maintain their status as non-LISs after the tax reform. This incentive is stronger among individual investors whose ownership is relatively close to 3%. When the ownership is in between 3% to 3.5%, 64.0% of the large individual shareholders sell stocks to restrict their ownership ratio below 3%. The percentage increases to 86.1% for those individual investors whose ownership is in between 3% to 3.1%. These results support that taxes affect stock selling.

The 2011 tax reform allows us to examine how taxes affect payout policy. Given that not all the investors that are affected by the tax reform sell stocks, the change in the tax code creases a cross sectional variation in investors' tax preferences on payout policy. Those investors who retain ownership ratio of 3% to 5% after the tax reform have an incentive to encourage managers to reduce dividends because the after-tax value of the dividends decreases. We find evidence for this hypothesis. However, the impacts are not economically large: a one point increase in dividend tax rate leads to a decline in the dividend-to-market capitalization ratio by 0.005 points.

Our paper contributes to the literature in several ways. First, various empirical studies show that taxes affect stock transactions.[82] However, none of these papers focus on stock transactions by large individual investors. Studying their tax incentives is important because they have considerable influence to change payout policy possibly for their own benefits. In addition, this is the first paper to use a natural experiment for identification to study the relationship between taxes and stock transactions. Second, we find evidence that tax incentives affect payout policy. This finding is in line with the findings in the U.S. (Chetty and Saez (2005); Pérez-González (2003)).[83]

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[82] Related papers include the followings: Barber and Odean (2004); Callaghan and Barry (2003); Desai and Dharmapala (2011); Hu, McLean, Pontiff, and Wang (2014); Ivković, Poterba, and Weisbenner (2005); Jin (2006); Korkeamaki, Liljeblom, and Pasternack (2010); Poterba and Samwick (2003); Poterba and Weisbenner (2001); and Starks, Yong, and Zheng (2006).

[83] Barclay, Holderness, and Sheehan (2009) study trades of large shares from individuals to corporations. Since the variation used in our paper is a reduction in stock holdings by individual shareholders, the authors use similar variation with ours. They find no evidence that the change in ownership caused by these transactions affects payout policy. Brown, Liang, and Weisbenner (2007) use the 2003 dividend tax cut in the U.S. as a source of exogenous change in after-tax value of dividends. They test whether a change in dividend policy in 2003 is a function of managerial ownership. They provide evidence that firms with higher managerial ownership are more likely to increase dividends.

We use a time-series variation in investors' tax preferences to identify the tax clientele effect.[84] Thus, our paper is relatively immune to criticism that the observed correlation is caused by third factors such as managerial quality.

The rest of this paper is organized as follows. Section 2 explains background information and develops hypothesis. Section 3 explains research design and describes data. Section 4 shows the estimation results. Section 5 concludes.

2. Background and hypothesis

The tax system in Japan makes a distinction among three types of shareholders: large individual shareholders (LISs); non-large individual shareholders (non-LISs); and institutional investors. The difference between LISs and non-LISs is a key in this paper. LISs refer to individual investors who own 3% or a higher level of corporate stocks under the current tax system. This 3% threshold is effective from a 2011 October tax reform. The threshold was 5% from 2003 March to the end of 2011 September. In other words, the tax reform changes the tax status of individual shareholders whose ownership is in between 3% to 5% from non-LISs into LISs.

The distinction between LISs and non-LISs has an important implication on the marginal tax rates on dividend income and capital gains income. Table 20 describes the tax rates for each class of investors as of 2012.[85] Table 20 shows that the top marginal tax rates on dividends for non-LISs (10%) are considerably lower than those for LISs (43.6%).[86]

This unique tax schedule leads to several hypotheses. First, LISs have an incentive to become

However, they do not find evidence that the impact of the dividend tax cut is a function of individual investors' ownership, although the tax cut can benefit all individual investors. Our finding is not consistent with the survey evidence by Brav, Graham, Harvey, and Michaely (2005) that taxes do not have first-order importance in payout policy.

[84] Recent papers that discuss tax clientele effects include the followings: Allen, Bernardo, and Welch (2000); Baker and Wurgler (2005); and Graham and Kumar (2006).

[85] There are no considerable time-series variations in the tax rates between 2003 and 2012. An example of a change in the tax rates is observed in 2007 when the top personal income tax rates are increased by three percentage points.

[86] This disparity in tax rates is caused by a difference in the availability of two types of tax accounts between non-LISs and LISs. The first tax account is used for ordinary income. Income on this account is subject to the personal income taxes whose top rate is 50%. The second tax account is prepared to eliminate progressivity of tax schedules for a certain type of income, and a flat tax rate of 10% is applied. Among non-LISs, both dividend income and capital gains income are eligible on this tax account. Therefore, non-LISs do not pay the ordinary personal income taxes for dividend income. In contrast, among LISs, only capital gains are eligible on this second tax account. Consequently, LISs' dividends are taxed as ordinary income. Although a dividend tax deduction of maximum 6.4% is available, the resulting top dividend tax rates for LISs are 43.6%. One might be concerned of the validity of the assumption that the top tax rates apply to large individual shareholders. Our data show that the average total dividend payments of individual firms are 2.66 billion yen in our final sample. Therefore, large individual investors whose ownership ratio is 3% receive 79.8 million yen of dividends. This amount exceeds the minimum income level at which the top tax rates apply (18 million yen). Thus, using the top tax rates in our analysis is appropriate.

non-LISs to reduce tax burden on dividend income. We test this prediction by examining whether non-LISs whose ownership is in between 3% to 5% before the tax reform sell stocks to maintain their tax status as non-LISs after the tax reform. Given that the tax reform is relevant only for dividend income, we expect that the change in tax code affects investors' incentives to sell stocks only when the firms pay dividends. Therefore, we test whether those individual investors sell stocks conditional on that the firms pay dividends.

The 2011 tax reform allows us to further examine hypotheses about the tax clienteles. Suppose that some LISs do not sell stocks, and therefore they remain in the company as LISs after the tax reform. Those LISs have an incentive to encourage managers to decrease dividends because the after-tax value of dividends declines after the tax reform.[87] In addition, LISs have an incentive to encourage managers to increase share repurchases. This is because share repurchases are more tax advantageous than dividends. More specifically, the dividends tax rates increase from 10% to 43.6% while the tax rate on capital gains remain the same and it is 10%.

3. Research design and data

Our main hypothesis examines if non-LISs maintain their tax status after the 2011 October tax reform by selling stocks. The unit of observations in this analysis is investors. The regressand is a dummy variable that takes one when the investor's ownership ratio is less than 3%. The main regressor is the interaction term of the following three dummies: a dummy variable that takes one when the ownership ratio is 3% or higher and lower than 5%; a dummy variable that takes one when the investors are individuals; and a dummy variable that takes one when the firms pay dividends. About the ceiling of the second dummy variable, we also use 3.5%, or 3.1% instead of 5%. The regression equation is represented by

$$own3low_{ijt} = \beta_1 own3toN_{ijt-1} \times ind_{ijt-1} \times div_{it-1} + \beta_2 X_{ijt-1} + investorFE_k + \epsilon_{ijt} \quad (1)$$

where subscript i represents firm, subscript j represents investor, subscript t represents year,

[87] Alternatively, these LISs can encourage managers to increase dividends to maintain their after tax gains from dividends. However, this behavioral response appears not to be rational because such behavior decreases firm value. Thus, we do not consider this possibility in our paper.

subscript k represents investor type[88], own3low is a dummy variable that takes one when the investor's ownership ratio is less than 3%, own3toN is a dummy variable that takes one when the investor's ownership ratio is 3% or higher and less than N% (N=5, 4, or 3.1), ind is a dummy variable that takes one when the investor is an individual, div is a dummy variable that takes one when the firm pays positive dividends, X include other variables (own3toN×ind, own3toN×div, ind×div, own3toN, and div)[89], investorFE represents investor type fixed effect, and ε represents error terms. We use the linear probability model and the Probit model for estimation.[90]

We also test whether LISs that retain over 3% of the ownership stakes after the tax reform encourage managers to change payout policy that is tax favorable for the investors. Note that the unit of observations is firms in this analysis because we are interested in individual firms' decisions on payout policy rather than investors' decisions. One of the main regressors in this analysis is a dummy variable that takes one when there remain LISs that retain their stakes of between 3% and 5% after the tax reform. More specifically, the dummy variable takes one when there exist LISs that hold ownership stakes of between 3% and 5% both in before the tax reform and in after the tax reform. We also include a dummy variable that takes one when the firms pay dividends, and the interaction of these two dummies because the tax reform is relevant for dividend income.

The regressand represents a change in payout ratio. The payout variable can be either dividends or share repurchases divided by lagged market capitalization. We use the first difference of the payout-to-market capitalization ratio as the regressand because we are interested in a change in payout policy before and after the tax reform. Other variables that can affect a change in payout policy is taken from Brown, Liang, and Weisbenner (2007). The variables are as follows: market to book ratio that is market capitalization plus liabilities divided by assets; cash flow that is after-tax profit plus depreciation divided by lagged assets; cash holdings that is cash on hand divided by lagged assets; leverage that is liabilities divided by lagged assets; past stock return that is stock return of past two years; monthly stock price volatility that is monthly stock price volatility of across previous five years; and log of market capitalization. We use a change in these variables as

88 Investor type refers to either individuals, business corporations, banks, insurance companies, securities companies, financial holding companies, other financial institutions, trust accounts, foreigners, governments, stock holding association, public entities, or others.

89 Note that we do not include the variable "ind" in the matrix X because it is captured by the investor fixed effect.

90 Because we include interaction terms in non-linear models, we use the estimation methods developed by Cornelißen and Sonderhof (2009) and Ai and Norton (2003) to interpret the coefficients from the Probit model as appropriate partial effects.

regressors because the regressand is a change in payout policy. The regression equation is represented by

$$D.payout_{it} = \beta_1 indown3_{it,t-1} \times div_{it-1} + \beta_2 div_{it-1} + \beta_3 D.X_{it} + \epsilon_{it} \quad (2)$$

where subscript i represents firm, subscript t represents year, "D." represents the one-year difference operator, payout represents either dividends divided by lagged market capitalization or share repurchases divided by lagged market capitalization, indown3 is a dummy variable that takes one if the firm has an LIS both in before the tax reform and in after the tax reform, div is a dummy variable that takes one when the firm pays positive dividend, X include control variables (market to book ratio, cash flow, cash holdings, leverage, past stock return, monthly stock price volatility, and log of market capitalization), and ε represents error terms.

We use Nikkei NEEDS Large Shareholder Database collected by Nikkei Digital Media Inc. This dataset discloses ownership information of maximum of the top 30 largest shareholders.[91] The average number of investors reported in the data per firm is 22.8.[92] We create an identification code using the name of the large investors to construct a panel data set. We keep observations whose fiscal year ends in March, which is most common in Japan, to make a fair comparison of the impacts of the tax reform in 2011 October. In other words, the years of 2011 and 2012 respectively refer to 2011 March and 2012 March in our paper.[93] The total numbers of investors and that of firms in 2012 are respectively 23540 and 1534.

An advantage of this data set is that it does not impose any restriction on the lower bound of the ownership ratio of investors about which firms must disclose. This is in contrast to the data in the U.S., where corporations need to disclose the ownership information of only those investors whose ownership stakes are 5% or higher. Our data show that the average lowest ownership stakes of the large shareholders across firms is 0.94%. Thus, this database discloses more detailed

[91] We therefore drop investor-level observations when we cannot make a distinction based on the names of the investors. This issue happens for example when the data report the name of the investors as just an "Individual Investor".
[92] The Japanese law requires firms to report information on the top ten largest investors. The Nikkei Digital Media collect more information by sending questionnaires to corporations. This procedure causes a difference in the number of large investors reported in the data.
[93] Our findings are not affected when we include firms whose fiscal year end is not March.

information than commonly used data sets in the U.S. We also use Nikkei NEEDS FinancialQUEST as the sources of other information on financial statements.

We present several graphs to provide suggestive evidence that ownership structure is affected by the tax reform. Graphically, we expect to see a bunching just below the thresholds where non-LISs change into LISs. Graph 1 presents evidence supporting our hypothesis. The left graph and the right graph respectively show the distribution of individual investors' ownership in 2011 and in 2012. The width of each bin is 0.02%. In the left graph, we see a bunching just below 5% ownership. On the other hand, we see that the bunching point is moved from 5% to 3% in the right graph. This comparison suggests that the tax reform encourages individual investors to sell stocks.

A potential concern is that this change in ownership is observed among non-individual investors as well. In this case, it is suspicious whether the tax reform has the impact that is consistent with our hypothesis, because the tax reform should affect only individual investors' incentives. Graph 2 presents the distribution of non-individual investors' ownership in 2011 and in 2012. These graphs suggest that the distribution is almost identical in these two years. These observations suggest that the tax reform affects incentives to sell stocks only among individual investors.

Table 21 describes summary statistics. Panel A reports summary statistics when the unit of observations is investors. This sample is used for equation (1). Panel B reports statistics when the unit of observations is firms. This sample is used for equation (2). Panel A shows that 8.3% of the total investors are individuals. Given that the total number of observations is 23540, the number of individual investors is close to 2000. In the total sample, the ratio of investors whose ownership is in between 3% and 5% is 16.4%. An unreported table shows that the number of individual investors whose ownership is in between 3% to 5% is about 350. In addition, nearly 90% firms pay dividends. Therefore, we have a considerable variation in the main regressor.

4. Results

Table 22 presents the estimation results. Columns (1) - (2) use the dummy variable that takes one when the ownership is between 3% and 5% as the main element of the regressor. Columns (3) - (4) and (5) - (6) respectively use the dummy variable that takes one when the ownership is in between 3% to 3.5% and in between 3% to 3.1% as the main element of the regressor. The odd numbered columns use the linear probability model and the even numbered columns use the Probit model.

Columns (1) - (2) show that about a half of the individual investors whose ownership is between 3% and 5% sell stocks so that their ownership ratio becomes below 3% when the firms pay dividends. Other columns show that the likelihood that investors sell stocks increases as the ownership ratio becomes closer to 3%. Column (4) and (6) show that 64.0% of the investors sell stocks when the ceiling of ownership ratio is 3.5%, and the ratio further increases to 86.1% when the ceiling is 3.1%. These results support that the tax reform encourages investors that are affected by the reform to sell stocks. This table also shows that the individual investors do not sell stocks when the firms do not pay dividends. This finding provides an additional support that the tax reform affects stock selling. Table 23 shows the estimation results of the falsification tests when we use year of 2010 in Panel A and year of 2012 in Panel B. None of the coefficients on the triple-interaction terms are positive and significant. These results provide a stronger support that the tax reforms affects stock selling.

Table 24 shows the estimation results on the relationship between the change in ownership induced by the tax reform and payout policy. Columns (1) - (2) use dividends as the regressand and columns (3) - (4) use share repurchases as the regressand. Columns (2) and (4) include an interaction term of an individual top dummy variable, which takes one when the individual investors who retain stakes between 3% - 5% after the tax reform are the largest investors, with the main interaction term used in columns (1) and (3).

Column (1) provides support that the change in ownership reduces dividends. This finding is consistent with the tax clientele hypothesis. Column (1) suggests that those firms that are affected by the tax reform reduce the dividends-to-market capitalization ratio by 0.165 point. Given that the top tax rates on dividend income are increased by 33.6 point, one point increase in dividend tax rate reduces the dividends-to-market capitalization ratio by 0.005 point. This finding suggests that the economic significance is not necessarily large.

In contrast, these firms do not change their policy on share repurchases. This might be because these individual investors are less likely to sell stocks in the near future and therefore the capital gains are not realized, given that these investors do not sell stocks as a result of the tax increase.

Column (2) provides evidence that whether the individual investors who retain the 3% - 5% of stakes are the largest investors or not do not affect our finding in column (1). This result suggests that the control power over future dividend policy does not yield our findings. This argument supports that the tax incentives affect payout policy.

5. Conclusion

We use a tax reform in Japan that raised the dividend tax rates for individual investors whose ownership ratio is in between 3% to 5% to test whether taxes affect stock selling and payout policy. We first provide clear evidence that these investors sell stocks to avoid the increase in tax burden. We then provide evidence that firms change their tax policy to consider the tax incentives of the investors who maintain their ownership ratio of 3% or higher. However, the impacts of taxes on dividends are not economically large. This second finding poses a question on what can explain this small impact of taxes on payout policy.

Table 20

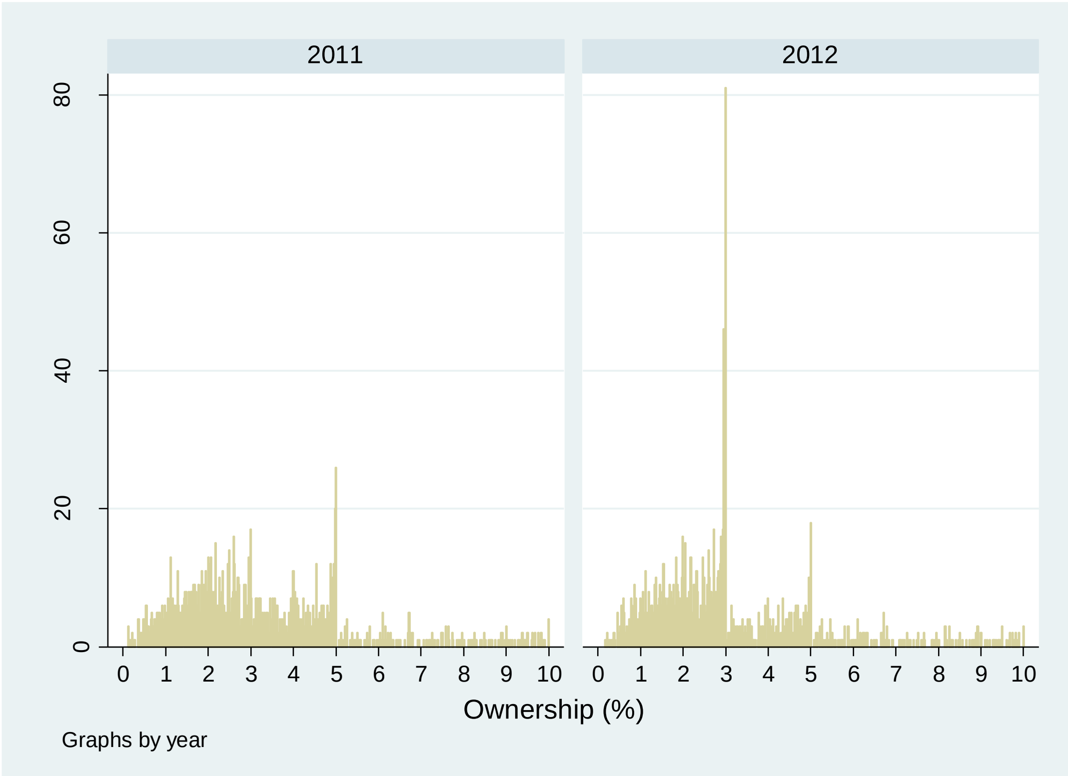
Tax rates in 2012

This table reports top marginal tax rates on dividend income and capital gains income for large individual shareholders (LISs), non-large individual shareholders (Non-LISs), and institutional investors, respectively. The year periods are in 2011-2012. LISs refer to individual investors who own 3% or a higher level of corporate stocks. This 3% threshold is effective from a 2011 October tax reform. The threshold was 5% from 2003 March to the end of 2011 September.

	Dividend income	Capital gains
Large individual shareholders (LISs)	43.6%	10%
Non-large individual shareholders (Non-LISs)	10%	10%
Institutional investors	19.5%	38%

Graph 1
Ownership of individual investors

These graphs describe the distribution of ownership ratio among individual investors. The left panel uses the data in 2011 and the right panel uses the data in 2012. The width of bin is 0.02.



Graph 2:
Ownership of non-individual investors

These graphs describe the distribution of ownership ratio among non-individual investors. The left panel uses the data in 2011 and the right panel uses the data in 2012. The width of bin is 0.02.

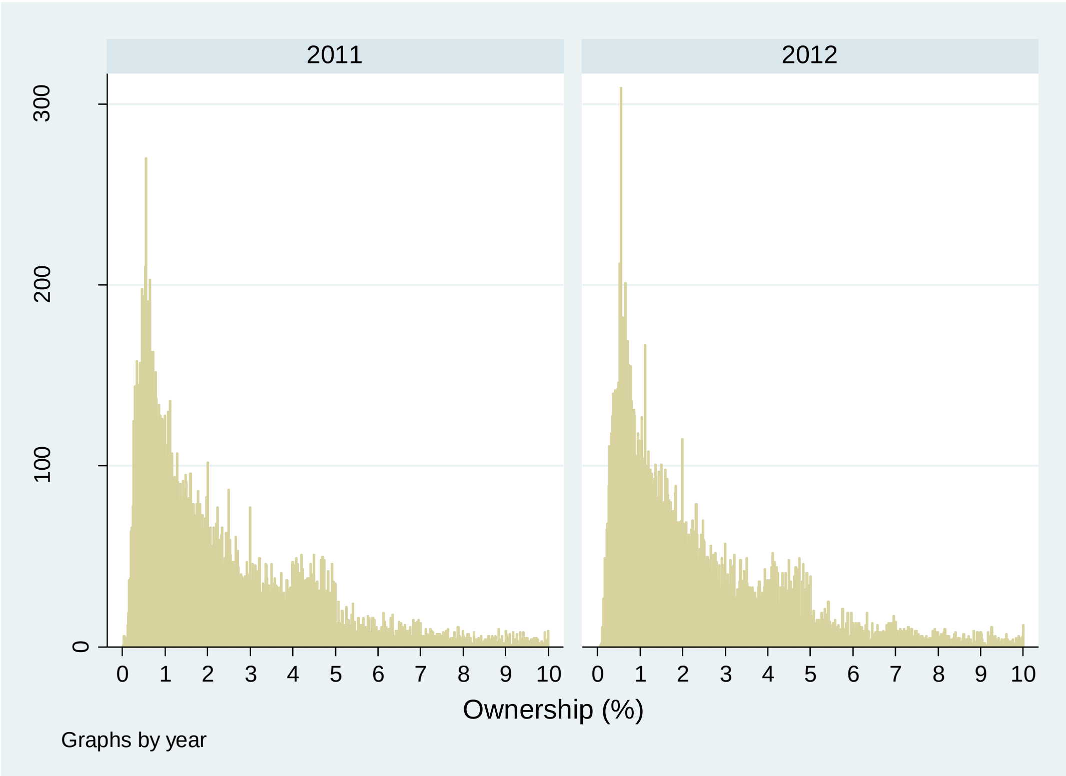


Table 21

Summary statistics

This table reports summary statistics in 2012. Panels A and B respectively report summary statistics at the investor-level observations and at the firm-level observations. The definition of the four dummy variables in Panel A is self-explanatory. In Panel B, market to book ratio refers to market capitalization plus liabilities divided by assets, cash flow refers to after-tax profit plus depreciation divided by lagged assets, cash holdings refer to cash on hand divided by lagged assets, leverage refers to liabilities divided by lagged assets, past stock return refers to stock return of past two years, and monthly stock price volatility refers to monthly stock price volatility of across previous five years. The term "difference" refers to the difference of the variable between in 2012 and in 2011.

Variable	Mean	SD
Panel A (investor level observation: N = 23540)		
Ownership ratio less than 3% dummy	0.712	0.453
Individual investor dummy	0.083	0.275
Ownership ratio 3%-5% dummy	0.164	0.370
Dividend paid dummy	0.876	0.329
Panel B (firm level observation: N = 1534)		
Difference in divided by market capitalization	0.190	1.426
Difference in share repurchases divided by market capitalization	-0.028	1.411
dividend divided by market capitalization	2.239	1.756
share repurchases divided by market capitalization	0.367	1.227
Individual with 3%-5% ownership dummy	0.124	0.330
Dividend paid dummy	0.870	0.337
Difference of market to book ratio	0.004	0.167
Difference of cash flow	-0.215	5.284
Difference of cash on hand	-0.038	5.287
Difference of leverage	1.501	9.593
Difference of market capitalization	0.038	0.245
Difference of market volatility	-1.388	3.528
Difference of five-year stock return	12.099	28.697

Table 22
Taxes and stock selling

This table presents estimation results to examine whether individual investors sell stock as a result of the tax reform. We use the data in 2012. The unit of observations is investors. We use either the linear probability model or the probit model developed by Cornelißen and Sonderhof (2009) and Ai and Norton (2003). The regressand is a dummy variable that takes one when the investor's ownership ratio is less than 3%. The regressors include the following variables: own3toN that is a dummy variable that takes one when the investor's ownership ratio is 3% or higher and less than N% (N=5, 4, or 3.1); ind that a dummy variable that takes one when the investor is an individual; div that is a dummy variable that takes one when the firm pays positive dividends; and the interaction terms of the dummies (own3toN×ind, ind×div, own3toN, and div). We do not report the coefficient estimates of the interaction terms or the dummy variables. Robust standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Ownership ratio less than 3% dummy					
	(1)	(2)	(3)	(4)	(5)	(6)
own3to5*ind*div	0.459***	1.962***				
	(0.049)	(0.352)				
own3to3.5*ind*div			0.562***	5.134***		
			(0.071)	(0.224)		
own3to3.1*ind*div					0.787***	5.681***
					(0.142)	(0.423)
own3to5*div	-0.036	-0.223**				
	(0.022)	(0.110)				
own3to3.5*div			-0.038	-0.179		
			(0.044)	(0.158)		
own3to3.1*div					-0.075	-0.287
					(0.106)	(0.319)
Other variables included?	Yes	Yes	Yes	Yes	Yes	Yes
Investor type fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Partial effect	0.459***	0.519***	0.562***	0.640***	0.787***	0.861***
Estimation methold	Linear	Probit	Linear	Probit	Linear	Probit
N	23540	23540	23540	23540	23540	23540

Table 23

Taxes and stock selling: Falsification test

This table presents estimation results to examine whether individual investors sell stock as a result of the tax reform in the framework of the falsification test. We use the data of 2010 in Panel A and the data of 2012 in Panel B. The unit of observations is investors. We use either the linear probability model or the probit model developed by Cornelißen and Sonderhof (2009) and Ai and Norton (2003). The regressand is a dummy variable that takes one when the investor's ownership ratio is less than 3%. The regressors include the following variables: own3toN that is a dummy variable that takes one when the investor's ownership ratio is 3% or higher and less than N% (N=5, 4, or 3.1); ind that a dummy variable that takes one when the investor is an individual; div that is a dummy variable that takes one when the firm pays positive dividends; and the interaction terms of the dummies (own3toN×ind, ind×div, own3toN, and div). We do not report the coefficient estimates of the interaction terms or the dummy variables. Robust standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: year of 2010

	Ownership ratio less than 3% dummy					
	(1)	(2)	(3)	(4)	(5)	(6)
own3to5*ind*div	0.008	-0.431				
	(0.050)	(0.279)				
own3to3.5*ind*div			-0.008	-0.330		
			(0.112)	(0.414)		
own3to3.1*ind*div					-0.269	-1.130
					(0.368)	(1.049)
own3to5*div	0.020	0.080				
	(0.017)	(0.106)				
own3to3.5*div			0.006	-0.010		
			(0.039)	(0.149)		
own3to3.1*div					-0.029	-0.187
					(0.088)	(0.317)
Other variables included?	Yes	Yes	Yes	Yes	Yes	Yes
Investor type fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Partial effect	0.008	-0.039	-0.008	-0.034	-0.269	-0.300
Estimation methold	Linear	Probit	Linear	Probit	Linear	Probit
N	22783	22783	22783	22783	22783	22783

Table 23 – Continued

Panel B: year of 2012						
	Ownership ratio less than 3% dummy					
	(1)	(2)	(3)	(4)	(5)	(6)
own3to5*ind*div	0.033	0.071				
	(0.065)	(0.265)				
own3to3.5*ind*div			0.013	0.001		
			(0.146)	(0.428)		
own3to3.1*ind*div					-0.241	-0.669
					(0.299)	(0.848)
own3to5*div	0.002	0.044				
	(0.021)	(0.115)				
own3to3.5*div			-0.006	0.016		
			(0.043)	(0.160)		
own3to3.1*div					0.068	0.227
					(0.093)	(0.339)
Other variables included?	Yes	Yes	Yes	Yes	Yes	Yes
Investor type fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Partial effect	0.033	0.010	0.013	-0.011	-0.241	-0.232
Estimation methold	Linear	Probit	Linear	Probit	Linear	Probit
N	23258	23258	23258	23258	23258	23258

Table 24
Taxes and payout policy

This table presents estimation results to examine whether the investors that are affected by the tax reform but that do not sell stocks change payout policy. We use the data in 2012. The unit of observations is firms. We use OLS for estimation. The regressand is the first difference of either dividends or stock repurchases. Both of them are divided by lagged market capitalization. The main regressor is a dummy variable that takes one when the firm has individual investors that maintain their status as non-LISs both in before the tax reform and in after the tax reform, and the firm pays dividends. We also include an interaction term of this variable with an individual top dummy variable, which takes one when the individual investors who retain the stakes after the tax reform are the largest investors, in some columns. We include the first difference of the following variables as controls: market to book ratio that is market capitalization plus liabilities divided by assets; cash flow that is after-tax profit plus depreciation divided by lagged assets; cash holdings that are cash on hand divided by lagged assets; leverage that is liabilities divided by lagged assets, log of market capitalization, past stock return that is stock return of past two years; and monthly stock price volatility that is monthly stock price volatility of across previous five years. Robust standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Diff of Dividends/Marketcap		Diff of Repurchases/Marketcap	
	(1)	(2)	(3)	(4)
Individual top*Individual with 3%-5% ownership*Dividend paid		-0.034		0.037
		(0.170)		(0.197)
Individual with 3%-5% ownership*Dividend paid	-0.165**	-0.158*	-0.139	-0.146
	(0.080)	(0.086)	(0.132)	(0.157)
Dividend paid	-0.103	-0.103	-0.119	-0.119
	(0.102)	(0.102)	(0.091)	(0.091)
Diff of market to book ratio	-0.812**	-0.812**	0.021	0.020
	(0.325)	(0.325)	(0.475)	(0.476)
Diff of cash flow	0.029***	0.029***	0.006	0.006
	(0.010)	(0.010)	(0.008)	(0.008)
Diff of cash on hand	0.006	0.006	-0.023***	-0.023***
	(0.007)	(0.007)	(0.009)	(0.009)
Diff of leverage	0.005	0.005	-0.001	-0.001
	(0.005)	(0.005)	(0.005)	(0.005)
Diff of ln(market capitalization)	1.779***	1.778***	0.448	0.450
	(0.266)	(0.266)	(0.293)	(0.294)
Diff of stock volatility	-0.026***	-0.026***	-0.019**	-0.019**
	(0.010)	(0.010)	(0.009)	(0.009)
Diff of 5-year stock return	0.000	0.000	-0.002	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)
N	1534	1534	1534	1534

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